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Abstracts of Principal Articles

The Production of Components for Lambretta Motor Scooters..... P. 292

This third article on the methods employed by Innocenti, in their Milan factory, for the manufacture of Lambretta motor scooters, is concerned with operations on connecting rods and crankshaft components. Connecting rods are machined from steel stampings, which are first ground to thickness at each end on a rotary surface grinder. The large and small ends are then drilled and reamed, and a special machine is employed to mill oil transfer slots in the large end. Similar slots are next machined in the small end on a conventional milling machine. All the surfaces, except those of the big end bore and the adjacent side faces, are protected by copper plating during the carburizing operation, and the big end bore is semi-finish ground and subsequently honed to size. After the small end bore has been ground, a bush is fitted which is then fine-bored on a special machine. Crankshafts for motor scooters are made in two main parts, which are subsequently joined by pressing a crank-pin into holes machined in the crank flanges. After the shaft ends have been milled, the crankshaft components are centre-drilled on a special vertical machine, and then rough- and semi-finish turned on a copying lathe. Other operations are concerned with drilling and reaming the crank-pin and other holes, and hobbing driving splines on one component. (MACHINERY, 92—7/2/58.)

Transfer Line for Oldsmobile "Rocket" Engines ..... P. 304

To enable the output of Rocket V-8 engines to be increased, the Oldsmobile Division of General Motors Corporation, U.S.A., have installed a new transfer machine line with a capacity exceeding 75 per hour. Features of this installation include elaborate inspection equipment, automatic units for handling work between machines, and banking stations for the storage of partially machined components. In this article, reference is made to the principal stages in the machining of cylinder blocks, and special equipment illustrated includes an automatic gauging installation for checking 16 tappet holes; a gauging unit for checking crankshaft and camshaft bores and classifying the cylinder blocks; a gauging unit for checking eight cylinder bores simultaneously; and a hopper feeding installation on a transfer machine for the delivery of core plugs, which are automatically inserted. (MACHINERY, 92—7/2/58.)

Small-Batch Production on Tarex Automatics ..... P. 310

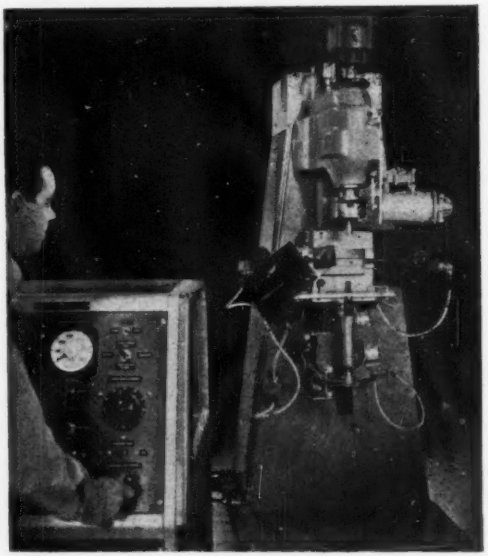
Tarex (England), Ltd., have recently introduced a system whereby their single-spindle, turret-type automatics can be employed effectively for the production of workpieces in small batches. All rough turning and boring operations are performed from the turret, and the external or internal surfaces are finished by a single-point tool, in a hydraulic copying attachment, mounted on the front cross-slide. Standard cams have been developed to reduce tooling costs, and tables and charts have been prepared in order to facilitate setting-up, the selection of speed and feed rates, and the determination of final cycle times. (MACHINERY, 92—7/2/58.)

Quantity Production of Needle Roller Bearings ..... P. 320

In the new chassis parts manufacturing plant of the Ford Motor Co., U.S.A., needle bearings for universal joints are produced in very large quantities. Blanks for races are cold extruded and, subsequently, are case-hardened and are then ground automatically, externally and internally, on Cincinnati, and Bryant machines. Races are distributed to the grinding machines by means of KDI automation equipment, and the faces are ground on Blanchard machines. Finally, 23 rollers and a synthetic rubber dust cap are assembled automatically to each race. (MACHINERY, 92—7/2/58.)

❖ ❖ ❖

For machining radio-active materials, this lathe is mounted vertically, and all motions that normally are hand controlled, are arranged so that they can be operated from a remote position. It is here seen undergoing tests in a laboratory of the General Electric Co., U.S.A.



Improving Productivity in Small- and Medium-batch Work

Application of the latest developments in production techniques, machine tools, handling equipment, and factory layout can bring about substantial improvements in productivity, and, during the past twelve months alone, attention has been drawn in MACHINERY to the application of such developments to the production of motor-car cylinder blocks, electrical switchgear, domestic appliances, and taper-roller bearings, for example, whereby remarkably high output rates are being achieved. Although these examples differ from each other in almost every respect, they have one characteristic in common, namely, that all the products are required in large quantities. In consequence, the cost of the elaborate manufacturing facilities provided, which may be very high, is distributed over such a large number of pieces that it represents only a very reasonable amount per piece.

When workpieces are required in more modest quantities, the provision of such elaborate production equipment is not economically justifiable, and recourse is had to expensive, specialized facilities, only when the accuracy of the final product cannot be achieved without them. Instead, reliance is usually placed on the use of good-quality, general-purpose equipment, with only such jigs and fixtures as may be considered essential. Indeed, where the batches of parts to be made are small, it may be the practice to rely solely on skilled operators, the use of jigs being entirely avoided.

The tendency to work without jigs is particularly evident in connection with drilling operations on small batches of parts, and marking out and "centre popping" are widely used for initially positioning the holes. Productivity is then relatively low, since the time occupied in setting up and re-positioning the drill or work assumes an unduly large proportion of the overall production time. The efficiency of such drilling operations can be substantially improved by the application of one of the many designs of co-ordinate tables that are now available, in various sizes, and with different methods of positioning. Such tables are employed by a well-known machine tool builder for drilling such parts as gearboxes, cover plates and motor supports, in batches of 10 to 30, and have enabled holes to be drilled in a fraction of the time formerly required. A positional accuracy of ±0·001 in. is maintained, using only simple bar type members to locate the workpieces initially, and standard clamps.

In connection with drilling and other operations on small batches of parts, advantage may be derived also from the use of temporary jigs, built from standard components. Such items have been available commercially for some years, and once the machining of a batch of workpieces has been completed, the jig can be dismantled, and the elements re-arranged for use with a different part. Somewhat similar arrangements are used by a certain manufacturer to facilitate the milling of workpieces in batches of about 30. The tables of a number of milling machines are fitted with base plates, to which suitable supporting, locating, and clamping members can be secured, as required. Before work is started on a batch of parts, the necessary members are mounted on the sub-base of a machine in accordance with identification marks. With the members fitted, the base becomes, in effect, a milling fixture, whereby the workpiece is efficiently located and clamped, and when the batch of parts has been completed, the positioning and clamping members can be removed, and used on another machine for a later stage. Since most of the members are used for several operations on a variety of workpieces, their cost, which is not excessively high, is spread over a large number of parts.

Much of the efficiency of large mass-production plants is attributable to the layout of the machines and equipment on flow-production principles, and the reduction of manual handling to a minimum. In most batch-production shops, machines are grouped according to their type, and with such an arrangement, a considerable amount of handling may be necessary before a workpiece is completely machined. In some instances, an analysis of the work done on particular machines may show that they are used mainly for certain broad classes of workpieces. It may therefore be possible to re-group these machines according to the components for which they are used, rather than by type. Simple roller conveyors could then be used for moving boxes or pallets of work, and handling would thus be greatly facilitated. With such an arrangement, a batch of workpieces would not necessarily start at the head of a line, nor would operations be performed by every machine, but it

(*Continued on page* 338)

The Production of Components for Lambretta Motor Scooters

Methods Employed in the Innocenti Works, Milan, Italy

Two previous articles in this series (MACHINERY, 92/60—10/1/58, and 92/176—24/1/58), were concerned with the general organization of the large Innocenti factory in the Lambrate district of Milan, Italy, and with the methods there employed for the production of pistons and cylinders for the well-known Lambretta motor scooters. These scooters are made at the rate of 500 per shift, and the factory operates for most of the year on a 2-shift system, the machine and assembly shops being laid out for efficient flow-production. A view in the main machine shop for Lambretta components is given in the heading illustration, and, for the most part, the machines are arranged in lines across the shop so that the components progress towards the track at the right-hand side, where they are assembled into complete engine units. Some components, for example spindles and gears, do not lend themselves so well to flow production methods, and the specialized machines employed for these parts, such as the Gleason (Buck & Hickman, Ltd.) gear generating machines in the foreground of the heading illustration, are grouped together.

This article is concerned with the manufacture of connecting rods and crankshaft components for the 150-c.c. capacity engine fitted to the Lambretta 150 LD motor scooter. A drawing showing the principal dimensions of the connecting rod for the 150-c.c. engine is given in Fig. 1, and it may be noted that the same rod is employed for the smaller 125-c.c. unit. The 150-c.c. engine has a stroke length of 58 mm. (2·284 in.) and the centre distance between the connecting rod bores is $116 + 0{\cdot}2 - 0{\cdot}1$ mm. ($4{\cdot}567 + 0{\cdot}008 - 0{\cdot}004$ in.). The connecting rods are machined from steel stampings, which are delivered in large box pallets to the starting end of the machining line. Here, the stampings are inspected, and, if necessary, they are straightened, and any twist is removed, by hand. The first machining operation, carried out on a Giustina RA2 N8 double-head surface grinding machine (Elgar Machine Tool Co., Ltd.), provides for rough grinding both sides of the two boss faces. This machine is shown in Fig. 2, and the grinding heads are so arranged that they operate on different bosses, the right- and left-hand heads being employed for the large and small ends respectively. Ring-type wheels are fitted to the spindles, which are driven at a speed of 950 r.p.m. At the side of each wheel head there is an adjusting unit which is controlled by a gauging head. This unit serves to adjust the height of the wheel face when the stylus, which contacts the face of the work being ground, is lifted above a pre-set level, as a result of wheel wear.

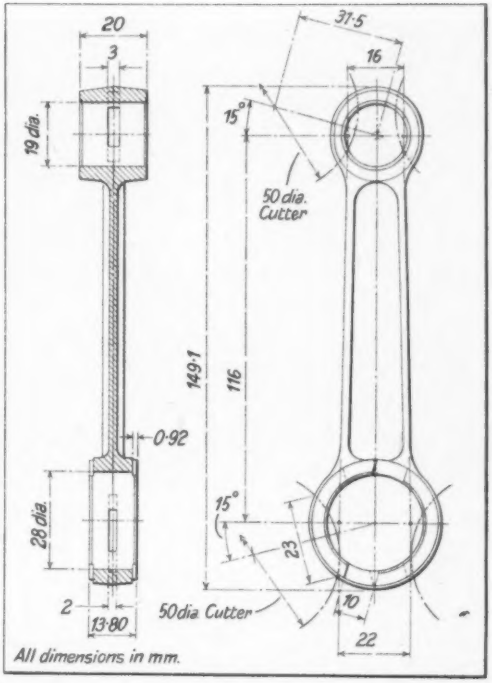


Fig. 1. The Connecting Rod for the 125- and 150-c.c. Engines for Lambretta Motor Scooters is Here Shown in Section and Elevation. The Big End Bore Forms the Outer Race of a Needle Roller Bearing

A close-up view of the work table, which turns in an anti-clockwise direction, is given in Fig. 3. - It is equipped with 24 simple work-holding fixtures, in each of which the connecting rod rests on flat surfaces and is clamped endwise against a fixed V-location by a spring-operated jaw, also of vee form. After the work has passed beneath the grinding wheels, the spring-loaded jaw is retracted by a cam as each fixture approaches the loading position, so that the rod is released and can be removed. The table rotates continuously, and as the freshly-loaded fixtures move towards the wheel on the right, the cams are disengaged and the components are clamped by the action of the springs.

Of the 24 fixtures, 12 are designed for holding 125- and 150-c.c. connecting rods, and the remainder accommodate rods for the 48-c.c. mo-ped engine.

In six of the 12 fixtures for the larger connecting rods, the components are supported at a lower level than in the remainder. Fresh stampings are loaded into these lower-level fixtures, and those which have been ground on one side are transferred to the higher fixtures. With this arrangement, approximately, the same amount of stock—up to 1 mm. (0·039)—is removed from all the boss surfaces, approximately 0·05 mm. (0·002 in.) being left for subsequent finishing. The 150-c.c. engine rods are ground, on both sides, at the rate of approximately 150 per hour.

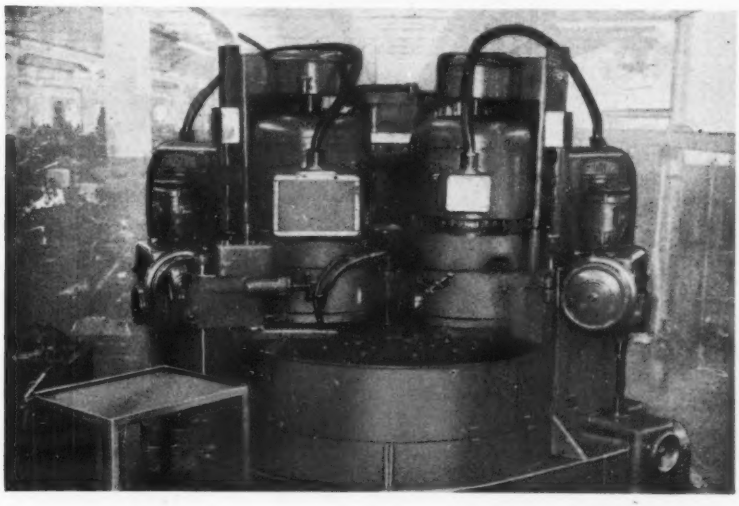


Fig. 2. The Faces of the Large and Small Ends of the Connecting Rods are Ground Flat and Parallel to Each Other on this Giustina Double-headed Rotary-table Machine

At the next operation on the rods, the two bosses are drilled and reamed on an Innocenti-built rotary table machine equipped with three fixtures. There is a loading station, and the two remaining stations have two-spindle heads equipped with drills and reamers for machining the bores

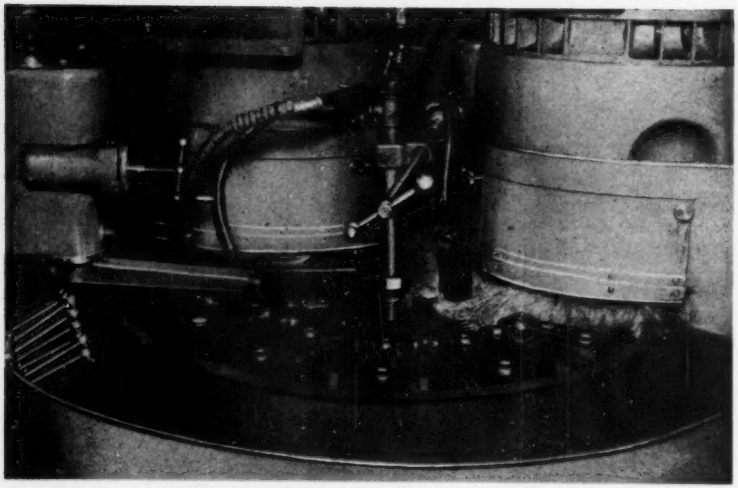


Fig. 3. Of the 24 Fixtures on the Table of the Giustina Machine, 12 are Employed for Connecting Rods for the 125- and 150-c.c. Motor Scooter Engines and the Remainder for Rods for Mo-ped Engines

to 28·45 ±0·07 and 18·65 ±0·07 mm. (1·1201 ±0·0028 and 0·7343 ±0·0028 in.). Both ends of each bore are next chamfered at an angle of 45 deg., to a depth of 0·5 mm. (0·02 in.) on a bench drill. Subsequently, two small oil holes (not shown in Fig. 1) in the small end boss adjacent to the web are drilled and counterbored. Each hole has diameters of 3·5 and 4·5 mm. (0·138 and 0·177 in.), and another Innocenti-built machine, equipped with a simple fixture and two small unit heads, is employed for this work.

From this drilling machine, the components pass to the special-purpose milling machine illustrated in Fig. 4, on which the two 2-mm. (0·079-in.) wide slots are machined in the large end boss. In the original design of connecting rod, the small end boss had a single slot, 3 mm. (0·118 in.) wide, and the machine shown in Fig. 4 was arranged to cut all three slots. The design has now been modified to include two slots in the small end, one on each side, and since the machine could not readily be adapted, these slots are now cut on a conventional milling machine at a later stage.

The machine in Fig. 4 has a base of weld-fabricated construction, and near the centre there is a pedestal with supporting surfaces for the connecting rod. On these surfaces the rod is located by stub arbors which project upwards. At the side nearest to the operator, the large-end boss is clamped by a draw-bar and C-washer arrangement, the bar being pulled downwards by an air cylinder within the pedestal. The other end of the rod is

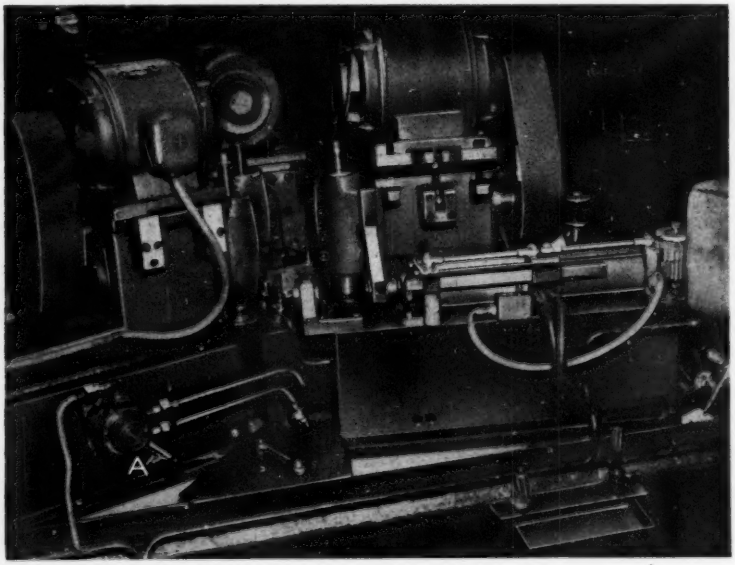


Fig. 4. A Special-purpose Milling Machine Employed for Cutting Two Oil-transfer Slots in the Large End has Heads which are Fed by Air Cylinders Under Hydraulic Control

clamped by a horizontal lever which is pivoted in a slotted bracket at one side. A second air cylinder, mounted on the flat surface of the machine base, pushes the outer end of the lever upwards to provide the clamping action. Both cylinders are controlled by the valve *A*. The milling heads are also mounted on pedestals and are moved on V-ways to bring the cutters into engagement with the work. Each head has a vertical spindle driven by a 1-h.p. motor, mounted above, through V-belts, a horizontal spindle and bevel gears. All the heads are of similar design and each is advanced and retracted by a combined air-hydraulic cylinder carried in brackets at one side of the top surface of the pedestal. These hydro-check units were supplied by the Italian firm Arco of Milan.

The ram of each air cylinder is connected to the milling head by a substantial bracket. As the head moves, it carries with it a bar of square section which slides in guides at the side of the cylinder. The bar has a cam surface on the underside which operates the plunger of a valve for controlling the flow of oil from one side of the piston in the hydraulic cylinder to the other, to reduce the rate of feed of the head as the cutter approaches the work. Fixed stops are provided to limit the total travel of each head, also a limit switch which is operated by a projection on the cam bar to reverse the direction of feed when the cutter has reached full depth. Each spindle is fitted with a 50-mm. (1·968 in.), diameter high-speed steel cutter which has 24 teeth. The cutter, which has 2-mm. (0·079 in.) wide teeth and a thickened central boss, is driven at 120 r.p.m., and a feed rate of 18 mm. (0·708 in.) per min. is employed. After the slots have been milled, the rods are transferred to an adjacent Galdabini hydraulic press of 5 tons capacity, on which the oil grooves shown in Fig. 1 are broached in opposite faces of the large-end boss. The machine is fitted with a massive fixture in which two components are held by toggle clamps. After each stroke of the press, one component is unloaded, the other is transferred from the first to the second position, and the vacant station is re-loaded with a fresh workpiece.

After the two slots in the small-end boss have been milled on a conventional horizontal machine, as mentioned above, the rods are packed into boxes and sent to the plating department to be electroplated with copper. This plated coating serves to localize the subsequent carburizing process, and the large bore is masked so that no copper is deposited on the surface. In addition, the copper is removed from the side faces of the large end on a Vagnone & Boeri emery band grinding machine. Carburizing is then carried out to a depth of slightly more than 1 mm. (0·039 in.), after which the rods are water-quenched to obtain a hardness of 60 to 63 Rockwell C scale in the bore and on the faces at the large end. On returning to the machine shop, the rods are again delivered to the start of the line, where they are once more inspected and straightened by hand. This straightening operation includes the correction of any twist caused by the hardening process. The large and small end bosses are then finish-ground to thicknesses of 13·8, $-0·032-0·075$ and 20. $+0-0·33$ mm.

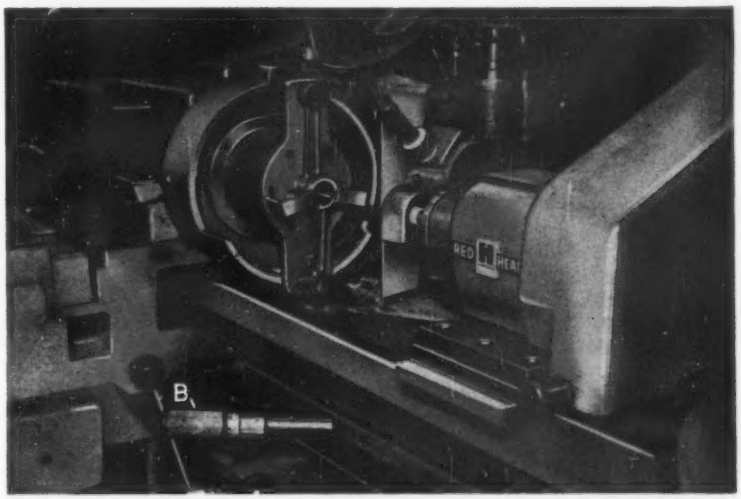


Fig. 5. Semi-finish Grinding of the Large End Bore is Performed on a Heald Machine with this Set-up at which Two Rods are Ground Simultaneously. The Mandrel *B* is Employed for Loading Purposes

(0·5433 – 0·0013 – 0·003 and 0·7874 + 0 – 0·013 in.), respectively, on the Giustina rotary surface grinding machine mentioned earlier.

Next, the large end bore is semi-finish ground on a Heald (Alfred Herbert, Ltd.) type 171 Gauge-Matic machine, about 0·003 in. being left on the diameter for removal at the subsequent honing operation. A close-up of this machine is given in Fig. 5, and it will be observed that it is equipped with a fixture which holds two rods. Pins projecting from the face-plate extensions locate the small end bores of the rods and the large ends are positioned with the aid of the mandrel *B*, which passes through both bores, and enters a locating bush in the centre of the fixture. With this mandrel in place, the rods are gripped at the sides of the big ends by two L-shaped clamps which are applied hydraulically, against spring pressure, from within the fixture. The mandrel is then withdrawn and the automatic grinding cycle is started. A Norton 32A-60L-S-VBE specification wheel is employed and is driven by the Red Head at a speed of 17,500 r.p.m., the work speed being 120 r.p.m. The automatic machine cycle provides for a roughing stage, after which the wheel is dressed, and the bores are then finish ground during a further short period.

An air gauge, that has been built by Innocenti, is employed for inspection of the bore diameters and has an arbor in which there are two air-escape jets of rectangular form, measuring approximately 2 by 5½ mm. (0·078 by 0·216 in.), on opposite sides. A similar unit is employed for final inspection, after honing, and is seen in Fig. 10.

The straightening operation, mentioned above, is carried out mainly for the purpose of ensuring that no excessively bent or twisted rods pass to the machining lines. Another—much more thorough—correction is now carried out. For this purpose, the rods are fitted with mandrels, and tests are carried out to ascertain whether the mandrels are parallel with each other in two planes. Adjustments to the rods are again carried out by hand, with the aid of a bench vice and bending bars, and dial indicator fixtures and a surface-plate are employed for checking. The mandrels, projecting from the two bores, are laid on the plate, and any lack of parallelism may then be readily observed. It is specified that the arbors must be parallel within ±0·15 mm. (0·006 in.) at a distance of 60 mm. (2·362 in.) from the centre line of the rod. Subsequently, the small-end bore is finish ground, ready for the insertion of the bronze gudgeon pin bush, on the internal grinding machine shown in Fig. 6, which was supplied by Officine Costruzione Meccaniche of Genoa.

The work-spindle of this machine also is fitted with a face-plate, and near the outer edge there is a stub arbor for the location of the large end bore. The small end of the rod is located for the grinding operation with the aid of the tapered mandrel *C*, the cylindrical end of which is passed through the bore into a bush at the centre of the face-plate. Screw-type clamps in brackets at the sides are next tightened, first lightly and then more securely, to grip the small end and hold it in the central position. The work is driven at about 600 r.p.m., and the complete work-head moves with the table towards the wheel-head. A grinding wheel of A54-M5-VBE specification is employed at a

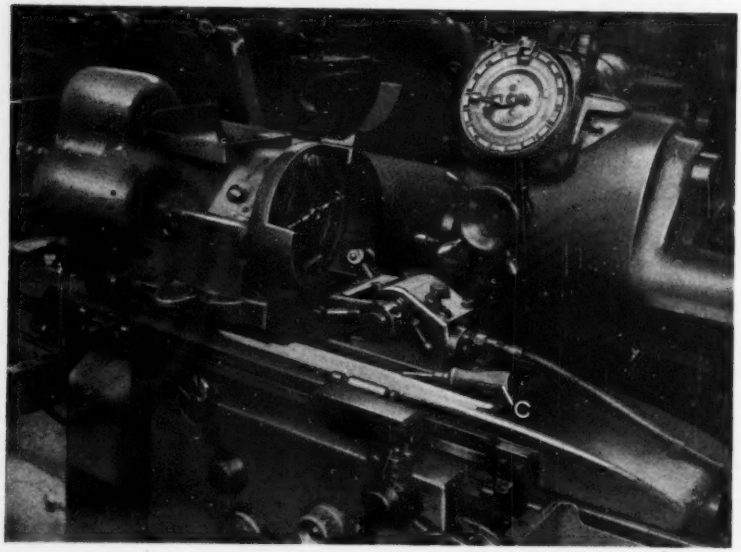


Fig. 6. Set-up on an O.C.M. Machine for Finish-grinding the Small End Bore in One Connecting Rod at a Time, Ready for Fitting the Bronze Bush. The Diamond Dressing Tool is Raised Hydraulically During the Automatic Cycle

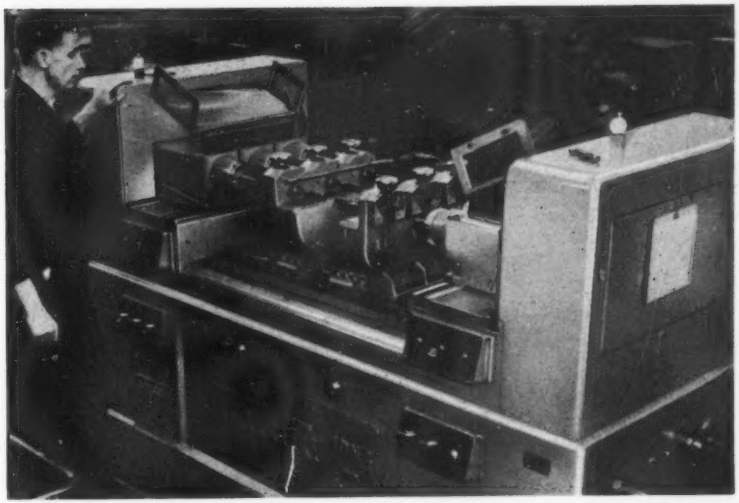


Fig. 7. General View of the Cimatic Fine Boring Machine Employed for Finishing the Bores of the Bronze Small End Bushes in Connecting Rods for the 125- and 150-c.c. Engines and for the Mo-ped Engines

speed of 29,000 r.p.m., and is dressed between the roughing and finishing stages of the automatic cycle by a diamond tool in a holder on the machine table. This holder is raised automatically for the dressing operation by a hydraulic cylinder within the cast housing. During the grinding operation, coolant is delivered through a hole in the work-spindle. Limits held on the nominal diameter of 19 mm. are $+0-0{\cdot}021$ mm. ($0{\cdot}7480+0-0{\cdot}00083$ in.). Sharp edges at the ends of both bores are next smoothed and chamfered with Desoutter type 211 bench-mounted air drills, to which the connecting rods are presented by hand. For the big end bore, a cone-shaped grinding wheel is employed, and for the small end, a cone-shaped cutter of high-speed steel with four teeth is used.

An air-operated mandrel press is employed for fitting the bronze gudgeon pin bush in the small end bore, and the ends of the bore in the bush are subsequently chamfered on a drill press with a rose countersinking bit. Inspection to ascertain that the narrower large end boss is accurately central in relation to the wider small end boss is carried out at this stage, and the parallelism of the faces of each boss is also checked. Oil holes are then drilled through the bush, in line with the holes in the small end boss which were drilled previously, and on the machine employed earlier for the small end boss, the slots are re-milled so that they break through into the bush bore.

Fine boring of the small-end bush is next carried out on the Cimatic 4 BN 4 machine shown in Fig. 7, which is provided with a fixture to suit both the 125- and 150-c.c. engine rods, also the smaller rods for the mo-ped engines. The machine is of conventional construction, with a central table arranged to move on guideways beneath the bridge members which carry the spindle heads. There are three spindle heads at each end, those on the left being used for the small mo-ped rods, and those on the right for the scooter engine rods. On the table are separate fixtures for the different sized rods, and a close-up view of the fixture for the larger component is shown in Fig. 8. The two fixtures are of similar design, and each holds three connecting rods in a vertical position, with the small end upppermost. When loading the fixture, the bore of the big end is engaged with a stub arbor, and a captive C-washer is then swung round so that the slot engages a reduced diameter on a draw-bar, the end of which projects from the centre of the arbor. This draw-bar is pulled inwards by a hydraulic cylinder to clamp the component when the loading operation has been completed.

When the rod is placed over the stub arbor, the small end is upwards, and it is positioned in a deep slot in the underside of a steel block which is fastened to the face of the fixture. A sliding mandrel, as seen at *D*, is then advanced into the bore of the bush in the small end to locate it for the boring operation. In bores in the side portions of the steel block are housed plungers which are lightly spring-loaded inwards. These plungers can be locked simultaneously in any position which they assume, by means of a star wheel in the top of the block, pressure being applied through an equalizing mechanism. For ease in loading, the spring plungers are retracted by means of the small levers at each side of the slot. After inserting the mandrel *D* into the bore, the plungers are released and are then moved inwards by their springs into contact with the outside surfaces of

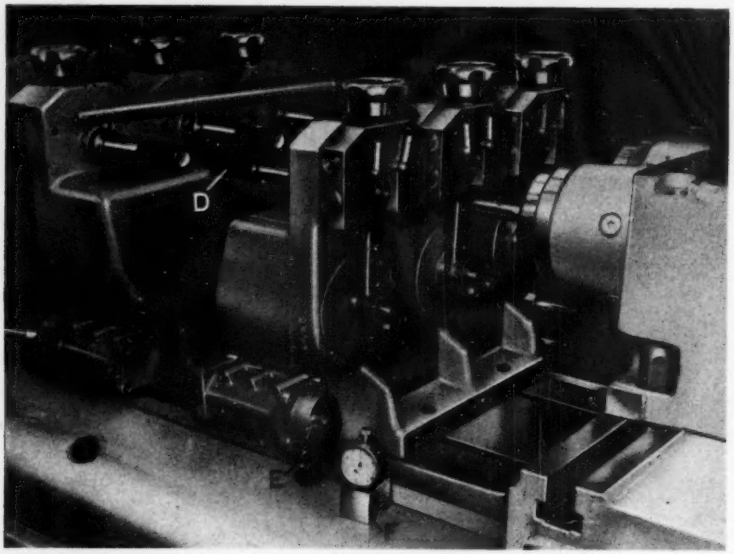


Fig. 8. Close-up View of the Fixture on the Cimatic Machine Showing the Method of Loading the Connecting Rods. The V-block Gauge *F* is Employed for Setting the Two Tools in Each Boring Bar

the small end boss, and locked in position. When all three fixture stations have been loaded, the valve *E* is operated, with the result that all three draw-bars are rolled inwards to clamp the large ends of the rods, and the locating mandrels are withdrawn. The loading operation is performed while the three smaller rods on the other fixture are being bored.

The spindles of the boring heads at the right-hand end of the machine are each fitted with two tungsten carbide tool-bits, one of which is employed for rough-boring and the other for finishing. There is sufficient space between the tools to ensure that the roughing operation has been completed before finish-boring is started. The spindles are run at a speed of 3,850 r.p.m., and the automatic cycle of the machine provides for fast traverse of the table to bring the end of the bore close to the roughing tool. A feed rate of 80 mm. (3·15 in.) per min. is then engaged, and the table is traversed at this speed for a distance of 53 mm. (2·087 in.). Finally the spindles are stopped, and the table is returned rapidly to the central position to complete the cycle. For setting the tools after re-grinding, the Etalon (Alexander S. Newall Machine Tool Co., Ltd.) gauge seen at *F* is employed. This instrument incorporates a V-block with a bore, normal to the vee, wherein is clamped a dial indicator

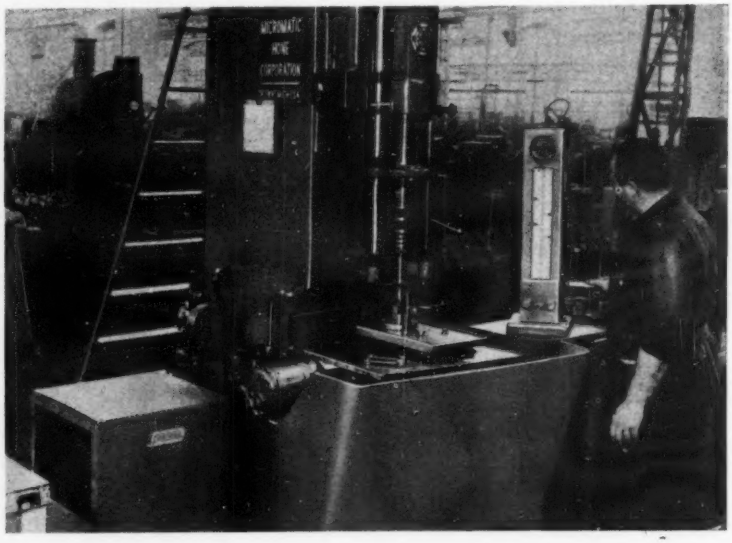


Fig. 9. On this Micromatic Machine for Honing the Large End Bores to Final Size, the Cutting Fluid is Cooled in a Heat Exchanger Housed in the Frostrode Cabinet at the Left-hand Side

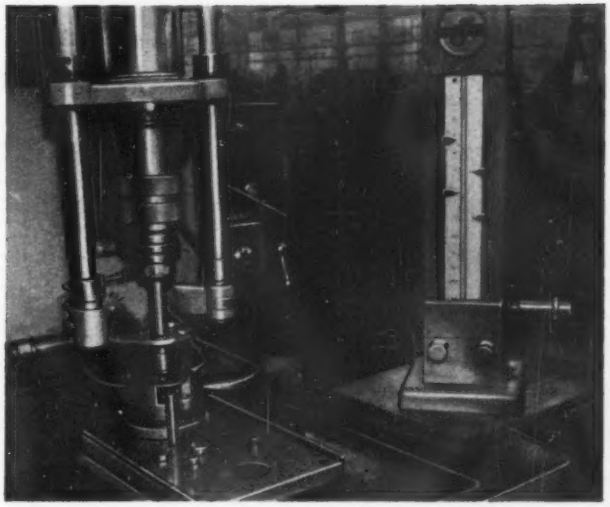


Fig. 10. Close-up View of the Micromatic Machine Showing the Method of Holding the Connecting Rods and the Innocenti-built Air-gauging Equipment for Checking the Bore which is Finished to a Tolerance of 0·013 mm. (0·0005 in.)

graduated in 0·01-mm. (0·0004-in.) divisions. The plunger of the indicator extends towards the vee, and when the gauge is placed on a shaft with the plunger in contact with the tool, the height of the latter above the shaft can be accurately measured. Limits of +0·016 +0·027 mm. (+0·00063 +0·00106 in.), are maintained on the 16-mm. (0·6299 in.) nominal diameter bore, on this machine, and the cycle time for three components is approximately 40 sec.

In the final crankshaft assembly, the bore in the large end of the connecting rod forms the outer race of a needle roller bearing, as will be explained in a later article. For this reason, the bore is finish honed, to a diameter of 28·9+0·013−0 mm. (1·1378+0·00051−0 in.), on the Micromatic (A. A. Jones & Shipman, Ltd.) vertical machine shown in Fig. 9. The paraffin mixture employed for this operation, it may be noted, is cooled in the Frostrode cabinet seen standing at the left-hand side of the machine in Fig. 9. This cabinet contains a heat exchanger through which the coolant is pumped, and the outlet temperature is maintained at 5 to 7 deg. C. (41 to 45 deg. F.). Wide air-temperature variations encountered in Northern Italy are thus prevented from affecting the accuracy with which the big end bores are finished. A close-up view of the honing machine and the fixture for the connecting rods is given in Fig. 10. The fixture is of simple design, with a support for the face of the big end, and stops to centralize the bore in relation to the honing spindle. A post projecting from the table in front of the fixture prevents the rod from being turned by the hone.

The hone employed is provided with five stones, and is driven at about 300 r.p.m. Stones of two different grades are employed for a preliminary operation depending on the hardness of the bores. The stone specifications are A280-18V-H22 and A280-JBV-H30, and with these stones the bores are semi-finished to within about 0·001 in. of the required size. A finishing operation is then carried out with a honing head equipped with stones of A320-L9V-H30 specification to bring the bores within the limits mentioned above, which correspond to a tolerance of approximately 0·0005 in. The size of the bores is checked, as honing proceeds, with the aid of the Innocenti-built air gauge seen at the right in Fig. 10, which has a projecting mandrel at the lower right-hand side. The scale on this gauge is graduated in divisions of 0·005 mm. (0·0002 in.) and the full length—about 2 ft.—represents 0·05 mm. (0·002 in.). Finally, the rods are inspected for straightness, twist, thickness and position of the bosses, and diameters of the bores, before they are taken to a press for incorporation in the crankshaft sub-assembly, as will be described in a later article.

OPERATIONS ON CRANKSHAFT COMPONENTS

As previously mentioned, crankshafts for the Lambretta motor scooter are of built-up construction and they are made in two main parts which are of generally similar form. Views of these two crankshaft components, with some of the principal dimensions, are shown in Fig. 11, the shorter splined shaft forming the driving end of the assembly. The other component is for the dynamo end and the circular flange portion of each shaft incorporates an accurately positioned and finished bore. A crank-pin with reduced diameter ends is pressed into the bores in each pair of shaft components, on assembly, to hold the complete shaft together. The crankshaft components are

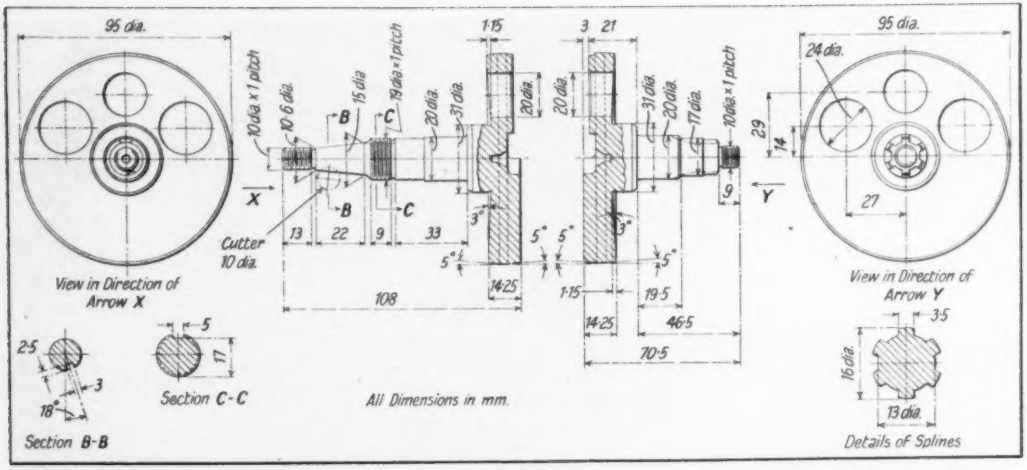


Fig. 11. Views of the Two Crankshaft Components for the 150-c.c. Engine with Principal Dimensions. On Assembly, the Two Shafts are Held Together by the Crank-pin

machined from steel stampings, and this article is concerned mainly with the operations on the driving shaft end, except where both parts are processed on a common machine. Initially, the shaft ends of both components, remote from the flanges or crank-throws, are face-milled on the Olivetti (British Olivetti, Ltd.), bed-type machine shown in Fig. 12, which is equipped with an indexing fixture.

This fixture is double-ended, and it can be turned through 180 deg. so that loading can be carried out at one end while machining of the components loaded during the previous cycle is proceeding at the other. Each end of the fixture is arranged to hold four components of each type, and they are accommodated in V-section channels machined in the flat top surfaces of two rectangular steel blocks. A deep slot in each block provides clearance for the crank-throw portion of each shaft, which is positioned end-wise from one face of the throw. Hinged at the further end of each steel block is a clamping member (seen in the raised position in Fig. 12), and each clamping member has a projection which enters a slot machined in the end face of the steel block. When the clamp has been lowered, a pin is inserted, through holes

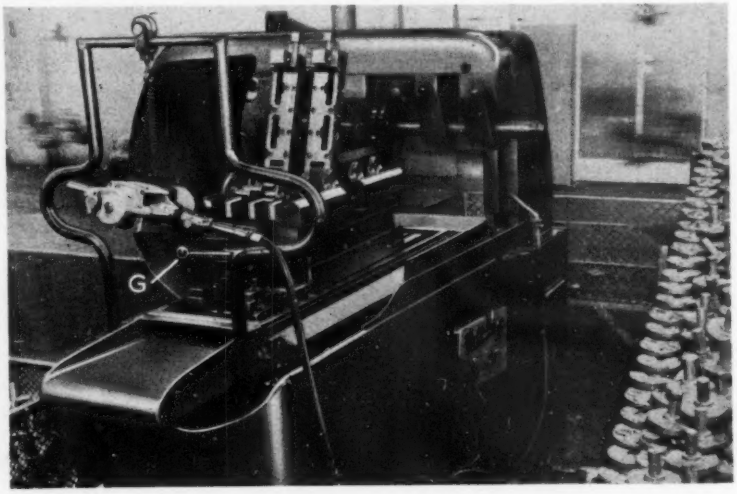


Fig. 12. For the Preliminary Facing Operation on the Crankshaft Components, this Olivetti Bed-type Milling Machine is Employed. Four Components of Each Type are Accommodated in the 180-deg. Indexing Fixture

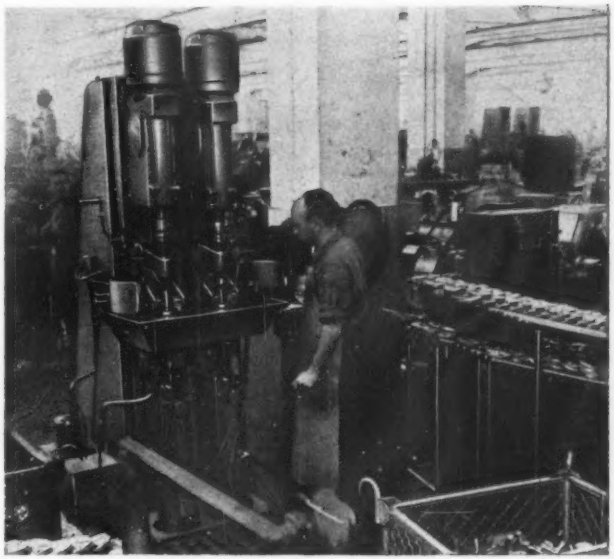


Fig. 13. For Drilling Centre Holes in Both Ends of the Two Crankshaft Components this Special Innocenti-built Drilling Machine, Fitted with Four Unit Heads, is Employed

provided in the projection and the cheek at each side, to hold it down while the clamping pressure is applied. Above the positions occupied by the shafts in the fixture, there are pairs of vertical bores in the clamping member. These bores accommodate plungers with serrated ends whereby clamping pressure is applied to the shafts. The bores all communicate with a common passage drilled horizontally in the clamping member, and the spaces above the plungers, and this passage, are filled with a semi-fluid plastics material which serves as a pressure-transmitting medium. At the front of each clamping member there is a square-threaded bore communicating with the horizontal passage and fitted with a substantial square-headed screw.

When the fixture has been loaded, and the clamping members secured in place by the pins, these screws, which now project horizontally from the front face, are driven in with the aid of the Fiap nut-runner shown. This tool is suspended, by means of a spring, from a grooved pulley wheel arranged to run on a horizontal bar which forms part of a framework secured to the table extension at one end of the machine. As the screws are turned, the pressure is transmitted by the plastics material to the plungers in the vertical bores, and thence to the shaft components. The upper part of the fixture is arranged to pivot on the base and is located by a square-section sliding key at one end. This key is withdrawn by means of the ball-handled lever *G*, which operates through a cam mechanism, in readiness for indexing. The upper part of the fixture is swung round by hand, past the 180-deg. position, and is then pulled back into contact with a spring-loaded pawl to position it accurately for the insertion of the square-section key, which also has a locking action. Two short and two long shaft components are held with the ends which are to be faced in alignment on each side of the central space between the supporting blocks. It is arranged that the ends of the shafts project slightly into this space, which is aligned with the cutters on the machine arbor. Twin 220-mm. (8·66-in.) cutters are fitted, each of solid high-speed steel, with 34 teeth. These cutters are driven at a speed of 22 r.p.m. corresponding to a cutting speed of approximately 50 ft. per min. and the table is fed at 4·72 in. per min. The depth of cut varies up to ⅛ in. Soluble oil is employed as a coolant.

From the milling machine, the shafts are passed to the special-purpose drilling machine shown in Fig. 13, on which both ends are centre-drilled in preparation for subsequent turning operations. Built by the Innocenti company to their own design, this machine has a column with a vertical face, at the centre of which there is a table supported on brackets. This table carries two fixtures, one for each shaft component, and each component rests with the flat end surface on three V-section ridges on the face of an annular pad. The component is centralized by an internal cone surface on the underside of a clamping bracket carried in guide-ways on the face of the column, as the bracket is moved downwards by an air cylinder. There are additional guideways on the column face for pairs of unit heads, above and below the table. The spindles of these heads are fitted with centre-drills, and are guided in bushes. After loading has been completed, a cycle-start button is pressed, and the heads are then advanced to drill the centre holes, and automatically retracted.

After they have been centre-drilled, the shafts are transferred to the first of two lathes on which

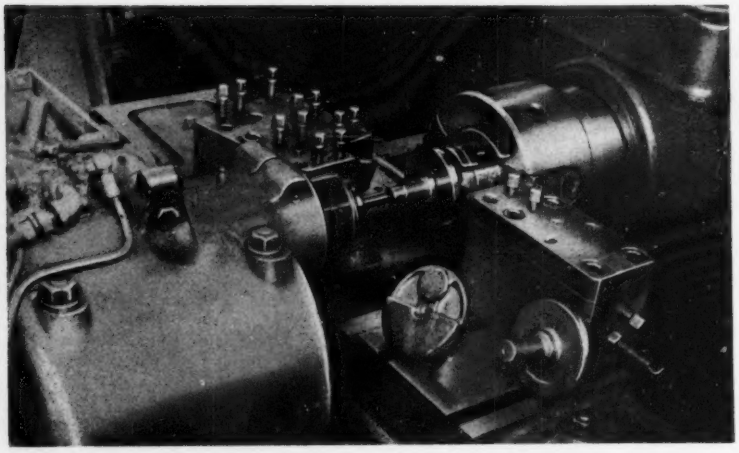


Fig. 14. The Outside Profile of the Shorter of the Two Crankshaft Components is Rough-turned on this Sundstrand Machine, to Relieve the Tools Employed for Subsequent Copy-turning

the outside profile is rough- and semi-finish turned. A view, from the rear, of this Sundstrand No. 8 automatic lathe (Rockwell Machine Tool Co., Ltd.) set up for the roughing operation on the shorter of the two shafts, is given in Fig. 14. The component is supported between centres with the outer face of the crank-throw in contact with a universally-mounted, air-operated support plate on the spindle, which assists in withstanding the cutting pressure during the facing operation. A driving pin projects from this plate into one of the depressions in the face of the throw, the form of which may be observed from the component lying on the rear slide in the foreground of Fig. 14. This rear slide carries a single tool, which is fed straight in to face the shaft side of the crank-throw and is then withdrawn. The front slide has a special holder which carries four carbide-tipped tools, and is urged outwards by a compression spring so that a follower on the underside is held in contact with a template corresponding to the contours required on the component. With these four tools, the flange is turned on the outside and chamfered at both corners, and two diameters on the shaft are turned. A spindle speed of 400 r.p.m. and a feed of 0·2 mm. (0·008 in.), per rev. are employed. These operations are carried out in order to lighten the work to be performed on the +GF+ hydraulic copying lathe (Vaughan Associates, Ltd.), which is employed for semi-finish turning, both machines being tended by the same operator.

The set-up on the +GF+ lathe is shown in Fig. 15. This machine is arranged for double-cycle operation when turning the shaft contours, and is equipped with a plunge-feed overhead slide for facing the flange. The shaft is held in the same manner as on the Sundstrand lathe, and the facing cut is first taken by the tool on the

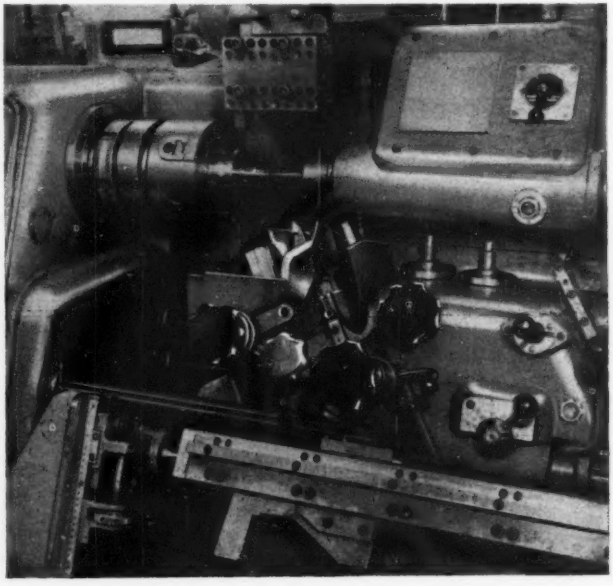


Fig. 15. Set-up on a + GF + Copy-turning Lathe for Finish-turning of the Shorter Crankshaft Component. The Automatic Cycle Provides for Two Cuts at One End of the Shaft Portion

vertical slide, at 500 r.p.m., with a feed of 0·22 mm. (0·009 in.), per rev. This face, it may be noted, is concave to the extent of 1·15 mm. (0·045 in.), at the position adjacent to the largest shaft diameter and for this reason the upper tool slide is set at an angle of about 3 deg. The copying slide is then brought into operation and the first cut is taken on the two smallest shaft diameters. Next, the tool is returned to the starting position, the second of the two copying templates, seen near the bottom in Fig. 15, is indexed into position, and the final copying operation is started. During this stage, the five shaft diameters are turned and the side of the flange is finish-faced. A spindle speed of 1,400 r.p.m. is employed for the first turning operation on the shaft, and during the second copying stage the speed is progressively varied from 1,400 r.p.m. for turning the smallest diameter to 500 r.p.m. for facing. Feeds of the order of 0·2 mm. (0·008 in.), per rev. are employed. A similar series of operations is carried out on the longer shaft on two other machines of the same makes.

Subsequently, crank-pin bores of both shaft components are drilled, spot-faced, and reamed to a diameter of 19·5 mm. (0·7677 in.). An Innocenti-built drilling machine is employed which has two heads, each with two spindles, and the components are held in 3-jaw chucks on a hand-indexed fixture table, location being taken from the step in the face of the crank throw. Drills, of 19 mm. (0·748 in.) diameter, and spot-facing cutters are provided on the spindles of one head, and reamers of 19·5 mm. (0·7677 in.) diameter in the other.

Another somewhat similar machine is then employed to drill the lightening holes in the crank throw at each side of the crank-pin bore to a diameter of 24 mm. (0·945 in.), and these holes are chamfered on an adjacent bench drill. The six splines on the shorter of the two shaft components are next hobbed on two small Pegard machines, which are tended by a single operator. The shaft is held between centres, and located and driven from the crank-pin bore, and the climb hobbing method is employed.

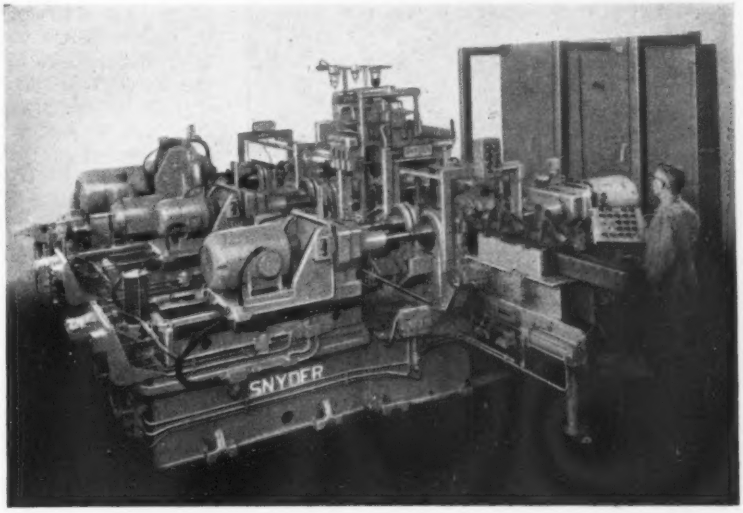
Final operations on the shaft components, their assembly into crankshaft-connecting rod sub-assemblies, and subsequent operations, will be the subject of a further article in MACHINERY.

Snyder Transfer Machine for Operations on Motor Car Parts

An in-line transfer machine for boring and tapping automobile differential housings and cap assemblies, as shown in the accompanying figure, has been designed and built by the Snyder Tool & Engineering Co., Detroit, Michigan, U.S.A.

This machine has seven operating stations, for rough, semi-finish and finish-boring two 3¼-in. diameter bearing holes, and cutting two large diameter threads in each bore. At the semi-finish boring operation, the diameter is held to a tolerance of 0·002 in. A feature of the machine is that, between the rough- and semi-finish boring operations, the assemblies are automatically clamped by pneumatic vices and the four bearing cap bolts are loosened, and re-tightened by air-wrenches, to relieve the stresses caused by the rough-boring.

A transfer system moves the parts through the machine, in pairs, at a rate of 180 per hour. The makers of the machine are represented in this country by Gaston E. Marbaix, Ltd., Devonshire House, Vicarage Crescent, London, S.W.11.



Snyder In-line Transfer Machine for Boring and Tapping Operations on Motor Car Differential Housing Assemblies

Transfer Line for Oldsmobile "Rocket" Engines

To provide additional production facilities to meet the increasing demand for Rocket V-8 engines, the latest advances in manufacturing techniques have been incorporated by engineers of the Oldsmobile Division, General Motors Corporation, U.S.A., in a new automated line of transfer machines. This line has a capacity of more than 75 engines per hour.

Increased output capacity has been obtained by incorporating integral inspection devices, additional machining heads, and a greater number of automatic work handling units. In addition, banking stations for the temporary storage of partially completed cylinder blocks are provided at various locations along the line, so that parts of the line can be shut down for maintenance and tool changes without interrupting the remainder. Operations which require more than the average time have been divided among several heads, and in some instances, identical operations are performed on alternate blocks at successive stations.

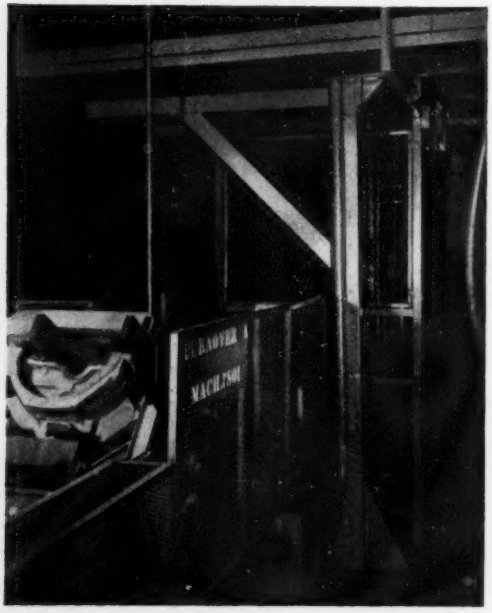


Fig. 1. At the End of the First Transfer Machine the Cylinder-block Castings are Turned Over and Elevated for Transport to the Next Machine which is Located on the Other Side of the Gangway

Cylinder-block castings are checked by means of a fixture gauge, and a Magnaflux Sonigage is employed to measure the wall thickness of the cylinder bores ultrasonically. Acceptable castings are unloaded from the shipping pallets and conveyed to the loading station of an Ingersoll 36-station transfer machine. Actually, this installation is made up of 10 individual machines interconnected to form two main sections. A total of 10 idle stations has been provided to accommodate tooling that may be needed to meet possible design changes.

Blocks are loaded into this first transfer machine with their sump faces downwards. After four locating pads have been milled on each block, and inspected with a fixture, the blocks are turned through 90 deg., by means of a rotating unit, so that the sump face is vertical. Next, the half-round crank bearings and the No. 5 cam bearing are rough-bored, and the sump flange and bearing cap seats are milled.

The bottoms and sides of the bearing-cap seats are finished in two passes by shaving with solid carbide blades. After the top surfaces have been rough- and finish-milled, the blocks are turned through a further 90 deg. so that the sump face is upwards. Two locating holes are then drilled, chamfered, and reamed, and the sides and anchor notches of the crank bearings, also the oil dipstick pad, are milled. Manually-controlled fixtures are employed to check the sump flange surfaces for flatness and the bearing-cap notches for depth.

Wilson equipment, as seen in Fig. 1, is provided at the unloading end of this first machine to turn the blocks over endwise, transfer them lengthwise, and elevate them to a transfer unit with a 10-ft. clearance over a gangway. A banking unit for storing partially-machined castings is also provided above the gangway, and, like the other automatic units, is hydraulically operated.

When the blocks have been lowered to conveyor height (40 in.) on the opposite side of the gangway, they are automatically loaded into a second Ingersoll transfer machine. Here the bank faces are rough- and semi-finish-milled, the cylinders are

rough-bored and chamfered, and the oil-filter pad is milled. Ingersoll "Shear-Clear" and "Cover Lock" cutters, with tungsten carbide-tipped blades, are used for milling and boring, respectively.

Both ends of the engine blocks are next rough-milled, the front end is finished-milled, and the rear end is semi-finished-milled, on another Ingersoll transfer machine. Various holes in both ends of the blocks—including the water pump, dowel, pipe tap, and camshaft holes—are drilled, chamfered, reamed, or tapped, and the cam bearings are rough-bored, on a Greenlee 32-station transfer machine. This machine is equipped with an automatic banking unit which has a capacity for storing 17 blocks.

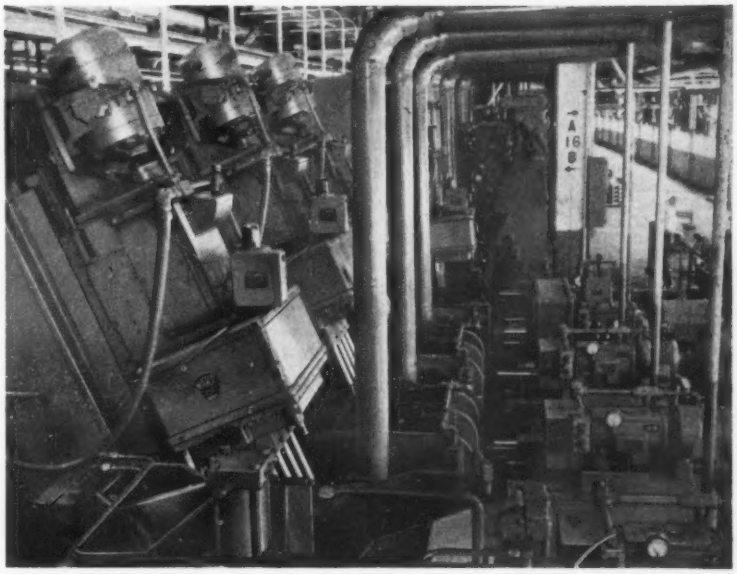


Fig. 2. This 18-station Transfer Machine Drills Holes in the Bottom and Side Faces of Cylinder Blocks at the Rate of More Than 75 per hour

Wilson equipment is employed to transfer the blocks from the unloading end of the Greenlee machine to the loading position on the Natco 18-station transfer type drilling machine, shown in Fig. 2. Another storage unit is provided at this position. On the Natco machine, holes for dowels, sump bolts, crankshaft bearing-cap bolts, oil draining, flywheel-housing bolts, oil-pump shaft clearance, oil-filter bracket attachment, and oil dip stick, are drilled in the bottom and sides of each block.

Another Natco straight-line type transfer machine, with 13 stations, is employed to drill, ream, chamfer, or tap additional holes in the top and side surfaces. All the drilled holes are inspected by probes at one station, and the blocks which are not acceptable are rejected at the next station. The workpieces are turned over, at two different stations, to dump chips. Both machines have hydraulic clamping and indexing units, and Cross control boards are provided for pre-setting and storing the cutting tools. Toolometers on these boards indicate when the tool should be changed.

Holes in the top and bank faces of the block are drilled and reamed, and the distributor hole is core-drilled and semi-finish-reamed on the Baush 35-station transfer machine seen in Fig. 3. The blocks are automatically loaded into the machine by means of a Wilson overhead transfer unit. A dummy bushing plate is provided at the second station to check the cavity in each block for clearance. At the loading end there is a block storage unit, which may be seen at the left in the figure. Blocks are loaded with the bottom faces downwards and front ends leading.

Eight push-rod clearance holes, of 1 in. diameter, are drilled in both bank surfaces by tools in left- and right-hand heads at stations No. 4 and 6. Vertical heads at the 16th and 18th stations each carry 19 spindles for drilling one 0·316-in. diameter distributor hold-down hole; chamfering two 0·261-in. diameter cover holes; and drilling 16 – $\frac{5}{16}$-in. diameter oil-reservoir holes in the tappet bores. Chips are dumped from the blocks by means of 180-deg. roll-over fixtures at stations No. 20 and 26. Vertical heads at the 32nd and 33rd stations are equipped with tungsten carbide-tipped tools for rough-core-drilling the distributor-shaft hole to a diameter of 1.3797 in. and semi-finish-reaming to 1·4377 in.

At the unloading end of this first machine, the cylinder blocks are again elevated, transferred overhead above a gangway, lowered, and automatically loaded into the next machine by means of Wilson equipment. An overhead banking unit and

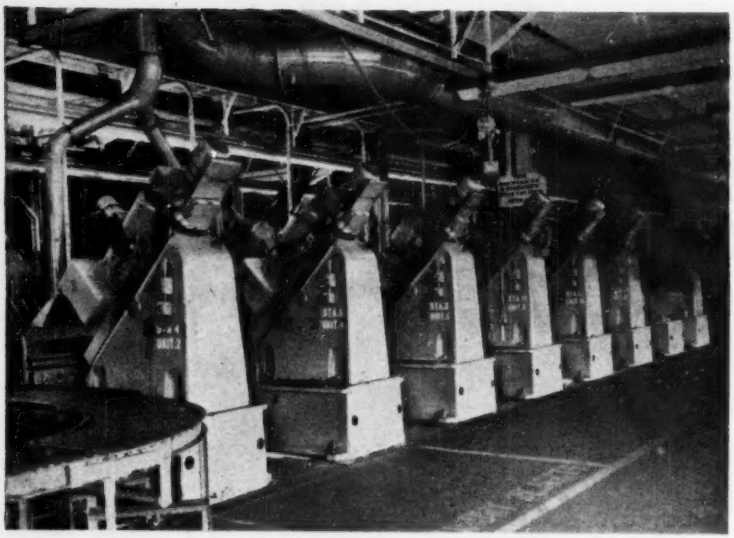


Fig. 3. The Top and Bank Faces of the Blocks are Drilled and Reamed, also the Distributor Hole on this Baush 35-station Transfer Machine

a 180-deg. turn-table are also provided. The remainder of the holes in the top and bank faces of the blocks are drilled, reamed, chamfered, or tapped on a second Baush transfer machine with 36 stations.

Blocks are loaded into this machine bottom face downwards and front end leading. At station No. 6, there are left- and right-hand heads and a vertical head equipped with probes for checking the 36 cylinder-head stud holes, the 16 tappet holes, and three other holes. Each probe has a hole for an air jet that serves to blow out the chips. The 36 cylinder-head stud holes are tapped (7/16-14 thread) by 18 spindle right- and left-hand heads at station No. 26. For checking the 16 valve-lifter holes simultaneously for diameter (0·9225 in.) at both bottom and top, and angle (45 deg.), a Sheffield Lectrolair automatic gauging assembly, as seen in Fig. 4, is built into the transfer machine at the 34th station. Blocks which do not pass this inspection are automatically ejected.

Clamping and indexing operations on both Baush machines are performed hydraulically. All the self-contained heads are arranged for mechanical feed by screw which ensures a constant traverse rate without the need for adjustment. The spindles are automatically stopped at the end of each cycle to reduce wear.

After the blocks have been washed, the bearing caps and bearing-cap bolts are assembled by hand and tightened to

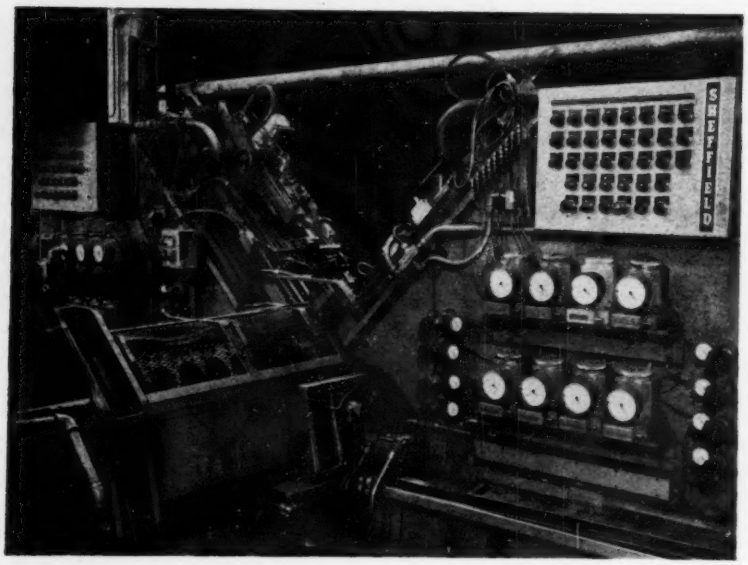


Fig. 4. This Automatic Gauging Assembly is Built Into a Transfer Machine for Checking the Diameters and Angle of the 16 Tappet Holes in Each Block

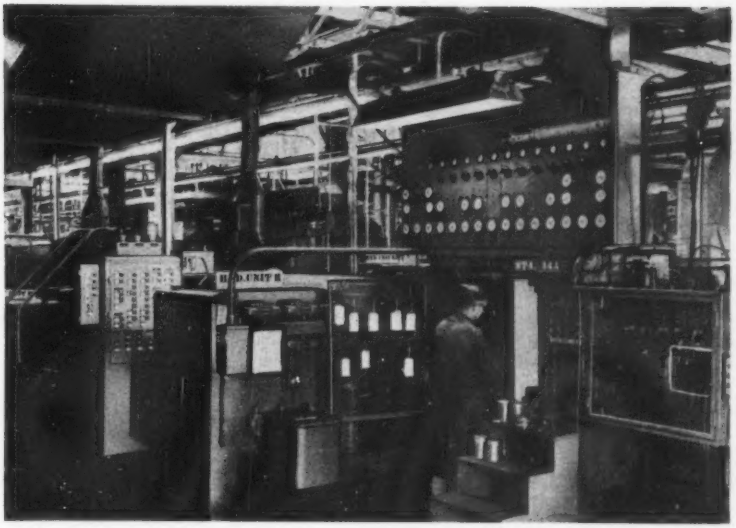


Fig. 5. Finish-bored Crankshaft Bearing Holes and the White-metal Camshaft Bearing Liners are Inspected by this Gauging Unit. Blocks of Different Classifications are Marked with Coloured Paints

the required torque, mechanically, with Keller nut-runners. Next, the cylinder block and lower housing sub-assemblies are loaded, sump face upwards, into another Ingersoll transfer machine. This machine is divided into three sections, with Wilson automatic transfer and storage units between them. Elevators are also provided between the first and second sections so that the blocks can be transferred over a gangway.

In the first section of this transfer machine, the camshaft holes are semi-finish- and finish-bored; the crankshaft holes are semi-finish-bored; the oil-seal and oil-slinger grooves are rough- and finish-turned; and the thrust-bearing surface is finish-faced and chamfered. The finish-bored camshaft holes in the castings are automatically inspected for diameter, and blocks not within the specified limits are rejected at station No. 9. In the second section of the machine, five, white-metal camshaft bearing liners are pressed into each block. Duplicate operations are performed on alternate blocks at the 12th and 13th stations, at which the five crankshaft bores in the main castings and caps are finished to 2·9370/2·9380 in. diameter, the five white-metal camshaft bearing liners to 1·9995/2·0010 in. diameter, the distributor-shaft hole to 1·515 in. diameter, and two dowel holes to 0·619 in. diameter.

A large combination air-electric gauging unit, shown in Fig. 5, has been built into the transfer machine at station No. 14, for automatically inspect-

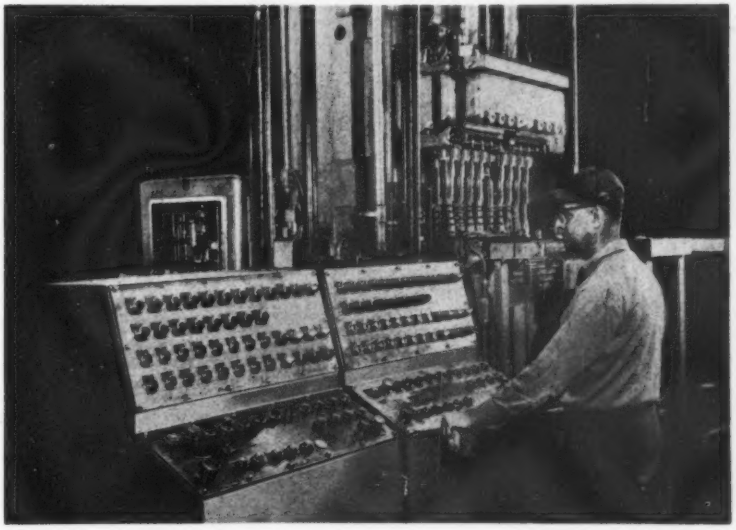


Fig. 6. This Eight-spindle, Vertical Machine is Employed for Rough-honing Cylinder Bores. The Blocks are First Turned on One Side and Then on the Other to Complete the Eight Bores

ing, classifying, and marking the blocks according to the sizes of the five finish-bored crankshaft bearing holes and the white-metal camshaft bearing liners. The gauging elements and classifying equipment were supplied by the Federal Products Corporation. A total of 20 inside diameters—two at opposite ends of each bore—is measured and the alignment of the oil holes in the white-metal liners is checked in relation to the oil holes in the cylinder block boxes. Crankshaft bores are checked for size and classified by marking with paints of different colours. Blocks with oversize, undersize, or misaligned bores are rejected. Signal lights are also provided to give a visual indication of the conditions of each block.

In the third section of the Ingersoll transfer machine, the bank surfaces of the blocks are finish-milled, and the cylinder holes are finish-bored to 3·9970 in. diameter. Cylinder boring is performed on alternate blocks at two successive stations. The bank surfaces are inspected for height, flatness, and angle by means of a manually-controlled fixture built into the line.

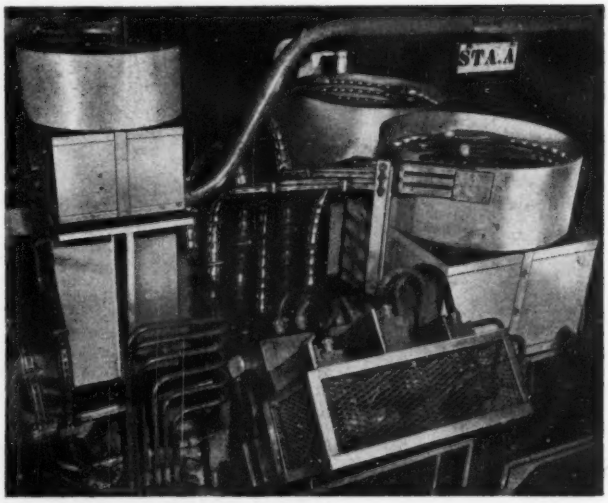


Fig. 8. A View Showing the Vibratory Hoppers and Feed Chutes Provided, on Top of a Transfer Machine, for Delivering Various Core Plugs for Insertion in Cylinder Blocks

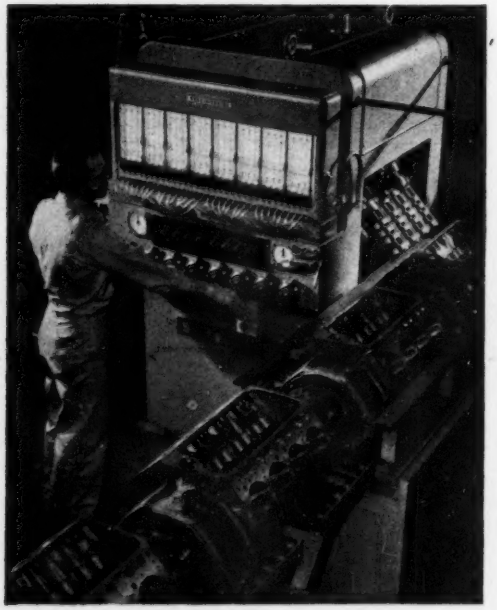


Fig. 7. This Automatic, Double-bank Inspection Machine Checks Eight Bores Simultaneously for Diameter, Out-of-roundness, Taper, and Bell-mouthing

Cylinder block and lower housing sub-assemblies then pass through a Centri-Spray washing machine, for which a turn-table loading mechanism and 27 block-holding fixtures are provided. Cylinder bores are rough- and finish-honed on two W. F. & John Barnes 8-spindle machines, one of which is seen in Fig. 6. Two blocks are handled simultaneously in each machine, and are first turned in one direction for honing the four cylinder bores in one bank, and then in the opposite direction for honing the four bores in the other bank. "Electro-Graphic" maintenance detector systems are provided to reduce electrical maintenance costs.

These machines are equipped with Jes-Cal honing tools and stones. Each double-cone type tool is attached to a rigid drive-shaft so that the need for universal joints is avoided, and is provided with a fully automatic mechanical sizing device. A self-centring sizing gauge, mounted on the drive-shaft above the hone, has carbide-tipped contact points. When the bore has been honed to a diameter that permits entry of the gauge, the stone-holder collapses and honing stops. Vitrified-bond, silicon carbide abrasive stones, $\frac{3}{8}$ in. wide by $\frac{5}{16}$ in. thick and 3½ in. long, are employed. For rough-honing, 180 grain size, R grade, and No. 9 structure stones are specified, and for finishing, 240

grain size, P grade, and No. 9 structure. A feature of this honing installation is the use of a water-soluble coolant known as Micro-Cool, instead of paraffin, so that fire risk is eliminated.

Cylinder bores are inspected for size and stamped on the Sheffield double-bank machine shown in Fig. 7. Diameter, out-of-roundness, taper and bell-mouthing of each of the eight bores are checked simultaneously. Each gauging spindle has tungsten-carbide wear strips and four sets of jets at different positions. In addition, the bores are classified, according to the diameter, at a point approximately 3·500 in. from the top, into either oversize, undersize, or one of 11 diameter classifications. Such classifications, identified by stamped letters, vary from each other by only 0·00025 in. on diameter. Out-of-roundness tolerance is 0·001 in., and the taper tolerance, 0·0007 in.

Cylinder blocks are again washed before they are finally inspected. Accepted blocks are automatically loaded into a final Ingersoll transfer machine on which core plugs, dowels, and the lower housing are assembled, and the rear of the block, also the lower housing, are finished-faced. Sealing compound is first applied automatically to the six core plug holes, from a compound metering unit and tank. At the next station, three core plugs are pressed into each side of the block, and one water-passage plug and one core plug into each bank surface. The vibratory feeding hoppers and chutes for delivering these core plugs are seen in Fig. 8.

The plugs are expanded by means of Ingersoll-Rand air tools and are inspected at the next station on the transfer machine. An air test of the water chambers for leaks is performed at station No. 5, and blocks which do not pass this test are ejected at the sixth station. At station No. 7, the blocks are turned through 90 deg., to position the rear ends towards the right-hand side of the machine. The four bolts for holding the flywheel housing to the block are tightened at station No. 8 and the rear ends of the block and housing are finish-faced at the final station on this transfer machine.

Equipment for Cutting Heavy Risers

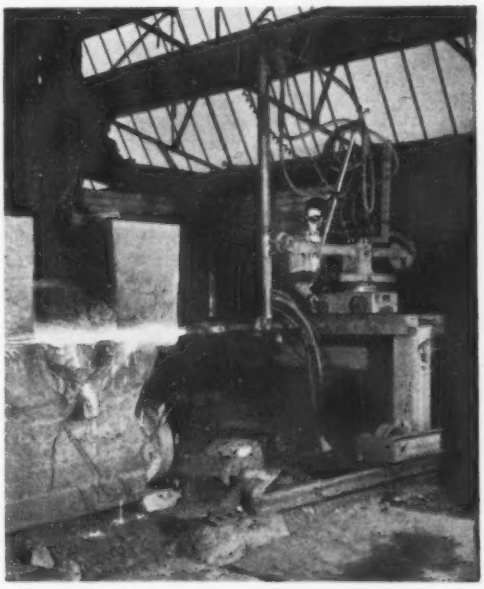
The riser cutting equipment shown in the figure, which is now in use in the heavy foundry at the Motherwell works of the Clyde Alloy Steel Co., Ltd., is reported to enable time savings of as much as 75 per cent to be obtained as compared with the former method of hand cutting.

A problem in riser cutting hitherto, has been to place the casting in a position in which it is accessible to the operator. This problem has been solved with the introduction of the new equipment, which was supplied by British Oxygen Gases Limited.

An overhead crane lowers the casting into place, and the cut is made with a horizontal and not a vertical flame. The head of the equipment can be adjusted over a wide range to deal with risers at varying heights. The oxy-acetylene cutter can deal with material up to 36 in. diameter, with oxygen at a pressure of 15 lb. per sq. in. for heating the 50 lb. per sq. in. for cutting.

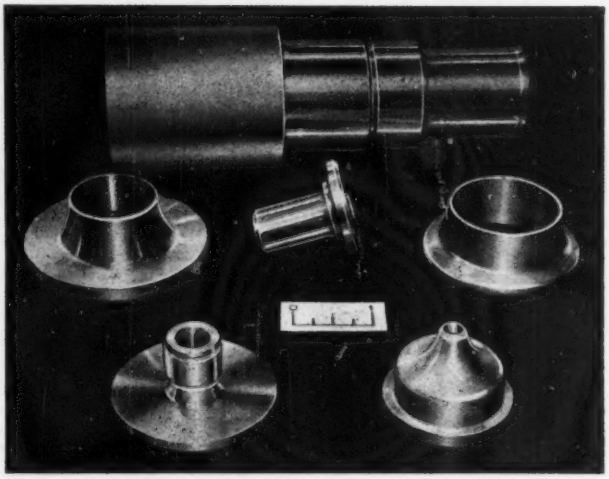
The Clyde Alloy Steel Co., Ltd., produce castings in a wide range of alloy steels, and when risers of chrome or stainless are being cut, iron powder is sometimes employed in conjunction with the flame.

The equipment is said to have proved of particular value for cutting risers from 18-ton chrome/molybdenum steel castings for turbine casings, required for a hydro-electric scheme.



Equipment Supplied by British Oxygen Gases for Cutting Risers from Heavy Steel Castings at the Motherwell Works of the Clyde Alloy Steel Co., Ltd.

Small-batch Production on Tarex Automatics



Tarex (England), Ltd., 22 Buckingham Gate, London, S.W.1, have recently introduced a system whereby their single-spindle, turret-type automatics can be employed effectively for the production of workpieces in small batches. This system was developed originally for machines of the TAR-H type, but it can be applied also to Tarex TAR-L automatics. Hitherto, both types of machine have been employed mainly for the production of turned workpieces in large quantities, particularly in the aircraft and instruments industries. It is considered, however, that they offer certain advantages for operations on workpieces that are required only in limited numbers, as compared with the manually-operated machines, such as capstan and centre lathes, that are usually employed for this class of work.

Most of these advantages stem from the fact that, on an automatic, the movements of the tool-carrying slides, and the actuation of the bar-feeding and chucking arrangements, are derived from positive mechanisms. For example, since the turret- and cross-slides are advanced by cams, cutting operations can be performed with greater consistency than is possible when the slides are actuated by hand. With the latter method of operation, the feeding force applied by the operator may vary from one component to the next. In consequence, the positions of the tools during cutting, and at the ends of their cutting movements, may differ, with consequent variations in component size. Moreover, the rate of tool movement may not be constant, with the result that finish may be inconsistent. Such effects do not occur on an automatic, and once the tools have been correctly set, work is produced within close dimensional tolerances, apart from a very gradual variation due to wear of the cutting tools. Furthermore, since the cutting and other motions of automatics are power operated, these machines can produce parts at higher rates of output than are practicable with manually-operated machines, as no allowance need be made for operator fatigue. Also, several operations can be performed simultaneously and tool clearances can be arranged more precisely, so that non-cutting times my be reduced to a minimum. In addition, a skilled operator is not required for each machine, and several automatics, once they have been correctly set, can be tended by an unskilled machine minder.

In spite of the advantages mentioned, automatics are not applied generally to small-batch production, because the cost of tooling and setting-up does not bear an economical relationship to the cost of the actual cutting operations, if only a small number of parts is to be produced. With the Tarex system, however, it is claimed that the tooling costs, and the time required for setting, are reduced to a minimum, and that, by adopting this system, Tarex machines can be used effectively for the production of workpieces in batches of as few as 40 parts.

Before considering the Tarex system in detail, it may be of advantage to examine certain features of the machines, since it is these features that have made possible the development of the system. Tarex TAR-H machines are of a particularly rigid construction, with a weight of 3½ tons, and are designed to withstand the heavy work involved in the removal of large quantities of tough materials, such as are encountered in the aircraft industry. A range of interchangeable spindle assemblies allows one machine to be used for bar or chucking operations. For bar work, up to a maximum diameter of 2½ in., a spindle assembly is employed which has a collet chuck, and pro-

vision for internal or external feeding of the bar, the machine then being designated TAR-H/64B. Alternatively, a 3-jaw, toggle-operated, hollow chuck may be fitted, again with provision for internal or external feeding, and the machine is then known as a type TAR-H/MMC. The same spindle assembly can be used for operations on blanks or forgings, and, in addition, two other assemblies are available, one of which has a 2- or 3-jaw mechanical chuck, with a positive work-ejector, and a spindle brake unit (machine type TAR-H/MM). The fourth spindle assembly has a 2- or 3-jaw pneumatic chuck and a brake unit (machine type TAR-H/MP). The mechanical and pneumatic chucks both have a maximum capacity of 7½ in.

The layout of the tool slides on the Tarex machine is conventional, as may be seen from Fig. 1. Two cross-slides are disposed horizontally, one on either side of the spindle, and a 6- or 8-station turret is carried on a slide that moves parallel to the spindle axis, the turret tools being arranged in the vertical plane. A third slide *A* is fitted as an integral part of the machine, and is inclined towards the rear in order to provide ample space for mounting attachments on the front of the headstock. The attachments include a fourth tool-slide *B*, also a hydraulic copying unit, the use of which forms the basis of the Tarex system, as will later be made clear.

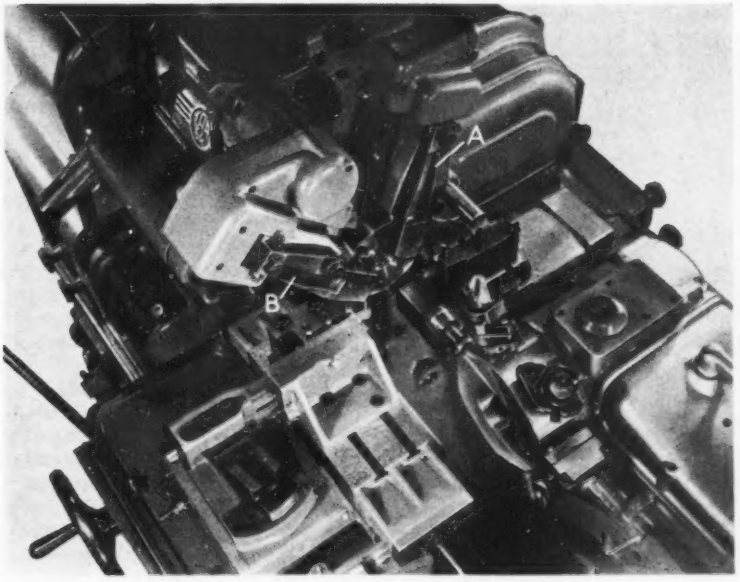


Fig. 1. General View of a Tarex TAR-H64 Single spindle Automatic, Showing the Disposition of the Various Tool Slides and the Turret

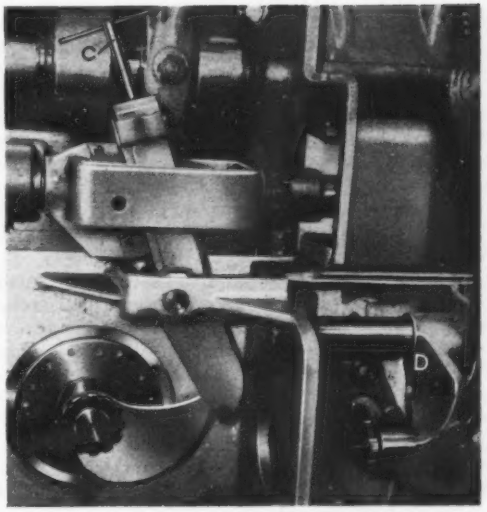


Fig. 2. View Showing the Cam for Moving the Front-slide Longitudinally, and the Scissors Levers whereby the Length of Travel can be Varied

All the slides are operated from camshafts in the orthodox manner, and the front slide can be moved longitudinally, as well as transversely. Longitudinal movement is derived from a disc-cam at the bar-feed end of the machine, and an adjustable "scissors" lever-system enables the ratio between the motion of the cam-follower and the slide to be varied from 1 : 1 to 1 : 2·5. This arrangement allows the travel of the slide to be modified, without changing the longitudinal motion cam. A close-up view of the cam and scissors lever is given in Fig. 2, and the ratio of movement is adjusted by means of the socket key *C*, in conjunc-

tion with a scale. At *D* in this illustration may be seen the cam-follower for the fourth slide attachment.

A similar lever system is employed to transmit motion from a cam at the rear of the machine to the rear cross-slide, so that the ratio between the movement of the cam-follower and that of the slide can be varied from 1:1 to 1:2·5. The rear slide can be moved longitudinally by a pusher fitted to the turret, and a follower and template may be used to permit of turning tapers, for example. The third and fourth slides are operated by direct linkages from cams, but somewhat similar arrangements are made for varying the movement ratios, which, for these units, range from 1:1 to 1:2.

The Tarex machine incorporates an accelerator unit for the camshaft, and this unit is exploited effectively in the system for small-batch production. By engaging the unit, the speed of the camshaft can be increased, to reduce non-cutting times or to by-pass, rapidly, any lobe on a cam that is not used. The accelerator is engaged by a trip on the main trip-drum of the machine, which actuates a one-revolution clutch to operate the driving clutch for the unit.

A view of the main trip-drum of the machine is shown in Fig. 3, and it may be noted that this drum provides for actuation of the mechanisms for turret indexing, chucking, bar-feeding, speed-changing, and direction-changing, in addition to the engagement of the accelerator. Thus, all trips are grouped conveniently in one position, so that setting-up is facilitated. The levers for the speed-changing, direction-changing and turret-indexing dog-clutches are seen above the drum, and the lever for the accelerator clutch is below the drum, as indicated at *E*. Adjacent to the accelerator trip lever, but not visible in the illustration, are the levers for opening and closing the collet or chuck-jaws, also for engaging the bar feed, when bar is being used, or for actuating the ejector, when chucking operations are being performed. At the right may be seen the cam and follower for the third slide, and the method of adjusting the ratio may readily be observed.

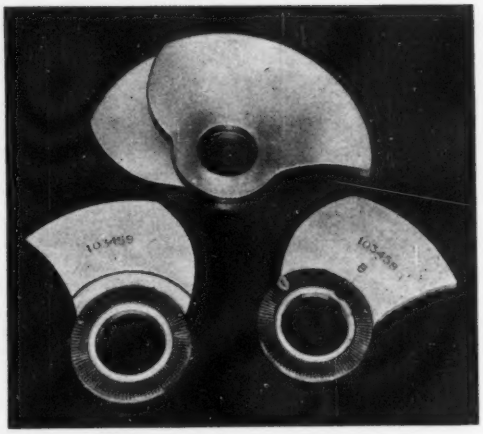


Fig. 4. Standard Fan Cams, for the Cross-slides, which can be Adjusted to Provide Dwell Periods of Different Lengths

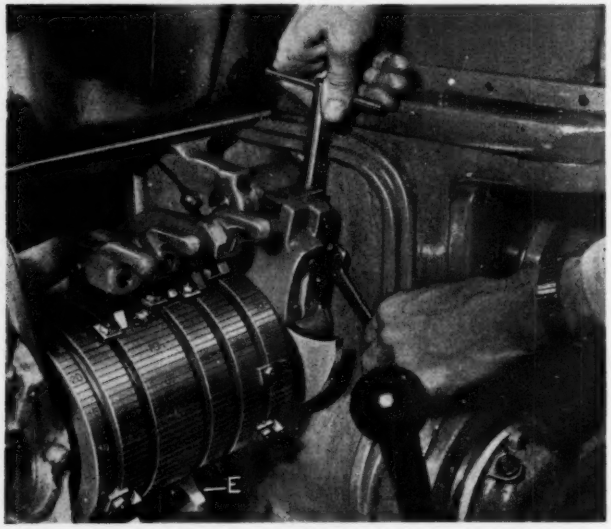


Fig. 3. The Trip-drum for Actuating the Speed-changing, Reversal, Turret-indexing and Other Mechanisms. The Setter is Adjusting the Variable-ratio Levers for the Third Slide

Adjustment of the ratio between cam-follower movement and slide movement, also the provisions for readily altering the relative positions of the cams, which are mounted on split carriers with 100 serrations, enables one set of cross-slide cams to be used for a wide range of different workpieces. It may be necessary, however, to arrange for the front slide to be fed inwards to a stop, and then to be held in that position while a longitudinal turning movement is carried out, the duration of the "dwell"

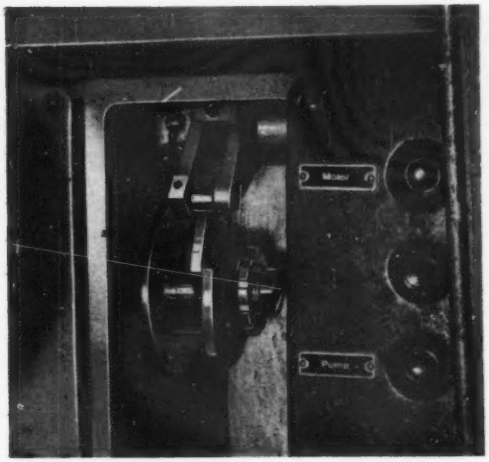


Fig. 5. A Pair of Fan Cams Set-up on the Machine for Operation of the In-feed Motion of the Front Cross-slide

period varying from one workpiece to another. To avoid the need for making a new cam for each piece, Tarex have developed so-called "fan" cams, examples of which are shown in Fig. 4. Three pairs of these cams are provided with each machine, and the cams of each pair are of similar shape, but of opposite hand. They provide for a rapid approach, a dwell period, and a rapid withdrawal, and by clamping the cams together, in various positions, the concentric surface, which provides the dwell, can be extended or decreased in length. By using the cams of the three pairs in different combinations, the duration of the dwell can be varied from 10 to 70 hundredths (of the cycle time). In Fig. 5, the smallest pair of cams is shown set up on the machine to provide a dwell period of approximately 20 hundredths. The surface of each cam which provides the dwell is ground concentric with the central hole, which is also ground, and from Fig. 5 it will be observed that the follower roller is of sufficient width to span both cam surfaces. A hundred serrations are cut on each cam to facilitate adjustment, and to prevent slipping.

HYDRAULIC COPYING ATTACHMENT

The Tarex system makes use of a hydraulic copying unit, which is one of the standard attachments available for use on the TAR-H machine. This attachment is mounted on the front slide, and movement of the cutting tool is controlled from a ⅛-in. thick template, which need be hardened only if large numbers of workpieces are to be produced. The attachment is completely self-contained, pressure-oil being delivered to the copy-turning slide from a pump and reservoir unit, attached to the base of the machine. A pump-driving motor of 3 h.p. is employed, and oil is delivered at a pressure of 215 to 285 lb. per sq. in. The tool carrying slide of the unit is positioned at an angle of 60 deg. to the work-axis (in the horizontal plane) and it has a maximum travel of 2½ in. (that is, 2·17 in. measured normal to the work axis), the minimum radius that can be turned being 0·020 in. Under control of the front slide cams, the complete slide assembly can be moved 4 in. longitudinally and 2¼ in. transversely. Faces are machined by using the template-controlled motion in conjunction with the normal cross-slide transverse movement. A maximum angle of 30 deg. to the work axis can be machined when the slide is advancing, and a maximum angle of 90 deg., when it is withdrawing.

SMALL-BATCH WORK

With the Tarex system for small-batch work, standard turret tools are employed for all roughing operations, and the copying unit is used for finishing. It is claimed that the accuracy of the

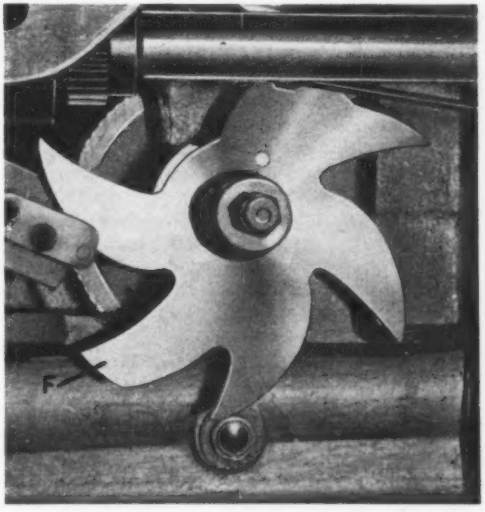


Fig. 6. The Standard Turret Cam Developed for Use on the Tarex TAR-H64 Automatic. It has Six Lobes which Provide Cutting Movements of Different Lengths

attachment is such that workpieces can be machined within 0·0005 in. of the required size, with a finishing cut of $\frac{1}{32}$ in. depth, and within 0·002 in., with a 0·2-in. cut. Reference has already been made to the standard fan cams supplied with the machine, and further standard cams have been developed for small-batch production. One of these cams is employed for parting-off the workpiece from the bar, and is designed to provide a stroke of sufficient length for the approach of the tool; parting-off a 2½-in. diameter work-material; and movement of the front edge of the tool past the bar-centre, so that the end of the work-material can be broken down by an angular cutting edge, in readiness for machining the next piece.

A standard cam with six lobes has been developed for the turret slide, and is shown in the close-up view, Fig. 6. The design of this cam has been based on the average requirements of a large number of operation cycles, and there is one lobe (at the top, and partially hidden, in Fig. 6) which provides for bar-feeding to a stop, or for hand loading, when chucking work is being undertaken. The lobe indicated at *F*, has a circumferential portion, concentric with the bore, which allows the turret to dwell in the advanced position, as may be required for internal recessing operations. The remaining lobes are designed for centre-drilling, turning, drilling, boring, fine-boring and reaming operations. Any lobe that is not required for a particular set-up can be by-passed by engaging the accelerator, by means of the trip-dogs, as already indicated. Once the accelerator has been tripped-in, the camshaft turns rapidly until the accelerator is disengaged, and then resumes its original speed.

TABLE I. BASIC INFORMATION RELATING TO STROKE-LENGTHS AND FEEDS PROVIDED BY STANDARD CAMS USED FOR THE TAREX SYSTEM FOR SMALL-BATCH WORK

Position	Slide	Operations	Stroke length, max. (in.)	Feed-rate (in.)	Spindle speed and direction*
1	—	Feed bar to stop or load by hand	—	—	—
2	Turret	Centre-drill, drill, bore or turn	2·000	0·004 0·006 0·014 0·0017	HF LB LF HB
3 and 4	Turret	Drill, bore, ream or turn	3·000	0·004 0·006 0·014 0·0017	HF LB LF HB
5	Rear	Groove, face or internal-recess	0·200 to 0·500†	0·0012–0·003 0·0018–0·0045 0·004–0·010 0·0005–0·0013	HF LB LF HB
6	Turret	Bore, ream or turn	3·000	0·004 0·006 0·014 0·0017	HF LB LF HB
7	Front	Copy-turning	5·000	0·004 0·006 0·014 0·0017	HF LB LF HB

* Spindle directions and speed ratios are as follows:—HF—High forward, 1·5 : 1; LB—Low reverse, 1 : 1 (basic); LF—Low forward, 0·43 : 1; HB—High speed reverse, 1 : 3·5.

† These figures apply to the length of stroke of the rear slide covered by the concentric (dwell) portion of the turret cam, and are steplessly-variable by means of adjustable ratio levers. Total length of stroke of rear slide ranges from 0·940 to 2·345 in. according to the lever setting.

SPEED AND FEED CHARTS

To facilitate selection of the cutting speeds and feeds, when the standard cams are used, Tarex (England), Ltd., have developed a range of charts, which are available in book form. These charts are used in conjunction with Table I, which indicates the basic feed rates for the various lobes of the turret cam, the rear slide, which is used for facing and recessing, and the front, copy-turning slide. On the Tarex machine, there are eight ranges of spindle speeds, and in each range, four speeds can be selected by means of the trip-operated spindle and gearbox clutches. The low speed in a reverse direction is regarded as the basic speed, and the ratio between this speed and the low speed in the forward direction is 1 : 0·43, between the basic speed and the high forward speed 1 : 1·5, and between the basic speed and the high reverse speed, 1 : 3·5.

The turret cam has been designed to provide a feed rate of 0·006 in. per rev. for lobes 2, 3, 4 and 6, at the basic speed. A stroke of 2 in. is provided by the second lobe, and of 3 in. by lobes 3, 4, and 6. At the other speeds, the stroke-length remains the same, but the feed-rates are altered in inverse proportion to the changes in spindle speed, as indicated in the table. It will be observed that lobe 5 is employed for grooving or facing, and for these operations a turret-mounted tool-holder is employed, which has a tool-carrying member arranged for transverse movement by the rear cross-slide. The stroke-length and feed-rates quoted for this lobe apply to the transverse movement, since the turret cam is employed solely to advance the tool, and hold it in the correct longitudinal posi-

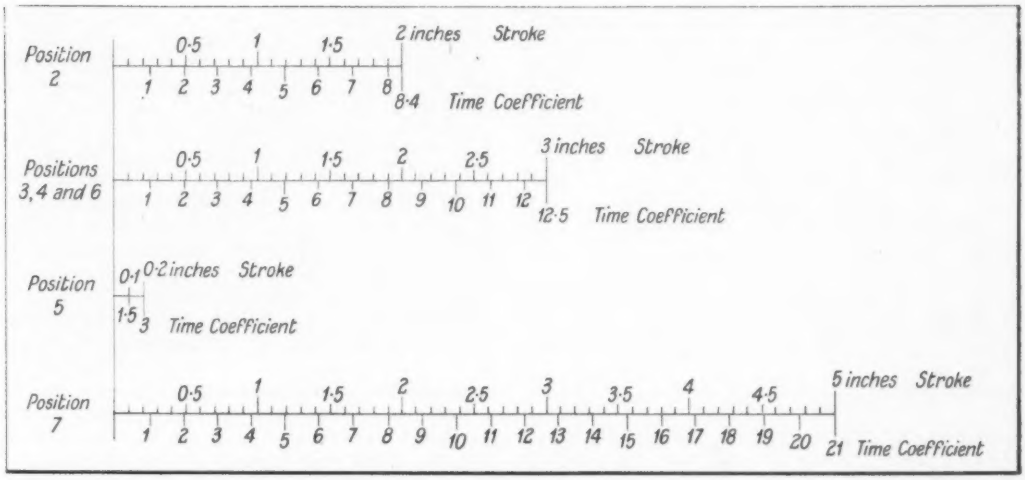

Position 2
0·5 1 1·5 2 inches Stroke
1 2 3 4 5 6 7 8 8·4 Time Coefficient
Positions 3, 4 and 6
0·5 1 1·5 2 2·5 3 inches Stroke
1 2 3 4 5 6 7 8 9 10 11 12 12·5 Time Coefficient
Position 5
0·1 0·2 inches Stroke
1·5 3 Time Coefficient
Position 7
0·5 1 1·5 2 2·5 3 3·5 4 4·5 5 inches Stroke
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 Time Coefficient

Fig. 7. From this Chart a Time Coefficient can be Determined, which Corresponds to the Length of Each Actual Cutting Movement

tion. It will be recalled that motion is imparted to the rear slide through a variable-ratio lever, and the stroke can, therefore, be varied steplessly from 0·200 to 0·500 in., and the feed rate for each speed is altered correspondingly, as indicated in the table.

In the table, a single-value is quoted for the stroke-length of the front slide employed for copy-turning, also for the feed-rate of this slide for each spindle speed. In practice, longitudinal motion is imparted to the front slide through a variable-ratio lever, and the stroke-length and feed-rate can be altered steplessly (to correspond to minimum and maximum ratios of 1 : 1 and 1 : 2·5) in a similar manner to the stroke and feed-rate for the rear cross-slide.

It will be appreciated that the full movement of the turret slide or cross-slides need not be used for actual cutting, and the chart shown in Fig. 7 has been developed to permit the conversion of the actual cutting stroke of each tool into a time-coefficient. For example, if a work-piece requires to be turned for a length of 1·2 in. by a tool at the third turret position, the time-coefficient for this operation is 5. The length of stroke is obtained by measuring an accurate, full-scale working drawing, with a rule, and the time-coefficients obtained for the various tool movements of the complete cycle are added together as indicated in Table 2.

On the Tarex machines, each of the eight ranges of spindle speeds is selected by means of two pick-off gears, and the highest and lowest speeds obtainable are 2,550 and 60 respectively. Charts have been prepared to facilitate the selection of the speed range which will provide the most efficient cutting speed for the type and size of work-material. One of these charts—for speed range No. 4 (123, 289, 430 and 1,012 r.p.m.)—is reproduced in Fig. 8. If 2-in. diameter steel bar is to be machined at a cutting speed of 150 ft. per min., it will be seen from the chart that a speed of 289 r.p.m. must be used, and that the spindle will run in the reverse direction. It may be pointed out that it might be more convenient to use one of the other speed ranges, in order to

TABLE 2. SEQUENCE OF OPERATIONS, STROKE LENGTHS, AND TIME COEFFICIENTS FOR A TYPICAL WORKPIECE PRODUCED BY THE TAREX SMALL-BATCH SYSTEM

Operation	Slide	Position	Length of working stroke (in.)	Time coefficient
Centre-drilling	Turret	2	$\frac{3}{8}$	1·5
Drilling and turning	Turret	3	$2\frac{1}{4}$	10·4
Drilling	Turret	4	$1\frac{1}{2}$	5·2
Internal recessing	Rear	5	$\frac{1}{4}$	1·9
Boring	Turret	6	$2\frac{1}{4}$	10·4
Copy turning	Front	7	$3\frac{1}{16}$	14·6
			Total	44·0

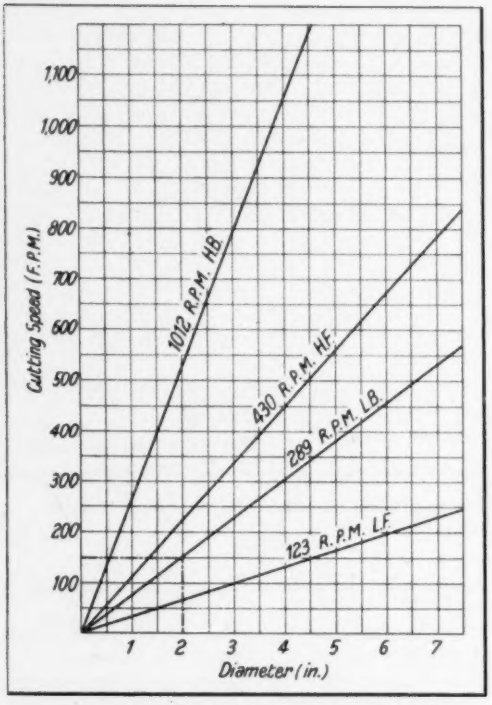


Fig. 8. A Chart of this Type is Provided for Each of the Eight Standard Speed Ranges to Facilitate the Determination of Cutting Speed

ensure effective cutting speeds for smaller diameters on the workpiece, and it would then be necessary to consult all the charts, in turn, to find the best compromise. For example, if it were required to machine a ⅞-in. diameter step at 150 ft. per min., the No. 2 speed range could be used. The high, reverse speed of this range is 619 r.p.m., giving a cutting speed of 140 ft. per min. for the ⅞-in. diameter, and the high, forward speed, of 263 r.p.m., would give about the same cutting speed for the 2-in. diameter.

Once the speed range to be used has been decided, the total operation time (in seconds) can be read from another chart, which is reproduced in Fig. 9. It will be seen that the horizontal ordinates correspond to the time coefficients. From the position on the horizontal scale, of this chart, that corresponds to the total time coefficient (see Table 2), a line is projected upwards to cut the line for the speed range which is to be used (No. 4). A line is then projected horizontally from this intersection, and the total operation time is indicated where this line cuts the vertical scale, in this instance 395 sec.

For each speed range there is a particular standard cycle time which will give the feed rates indicated in Table 1, as follows: — range 1, 1,600 sec.; range 2, 1,260 sec.; range 3, 980 sec.; range 4, 775 sec.; range 5, 635 sec.; range 6, 500 sec.; range 7, 390 sec.; and range 8, 308 sec. A pair of cycle-time pick-off gears is fitted to suit whichever speed range is being used. The cycle-time corresponding to the speed range does not represent the time required to produce a given workpiece, however, since not all the cam lobes, nor the full stroke provided by each lobe, may be used for cutting. These lobes, or parts of lobes that are not used, are by-passed rapidly by engaging the accelerator, and it is the sum of the actual cutting times and the time required for the accelated motions that is given by the chart in Fig. 9. If the feed rates are found to be excessive when a trial run is made, after initial setting up,

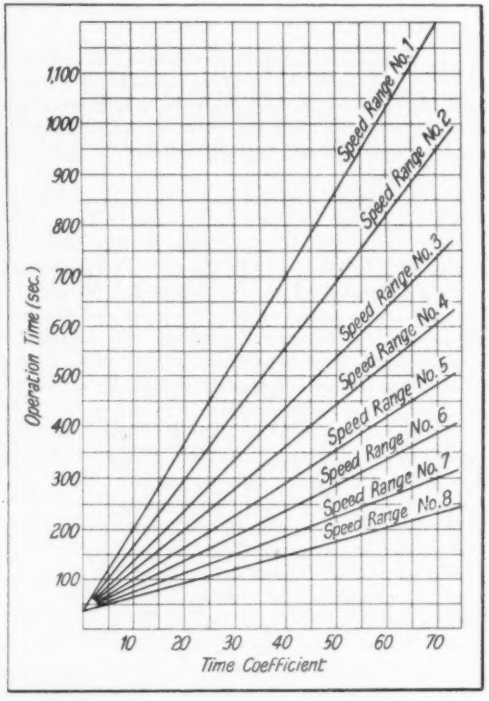


Fig. 9. From this Chart the Actual Operation Time can be Determined, once the Speed Range has been Selected and the Total Time Coefficient for the Complete Cycle is Known

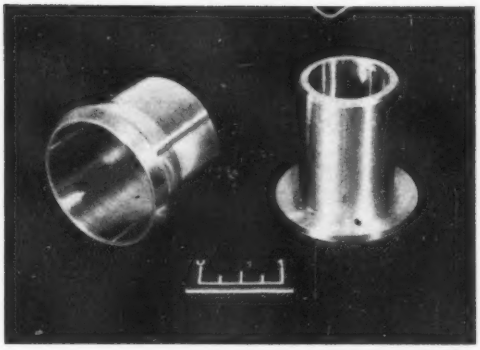


Fig. 10. Typical Components Produced in Small Quantities on Tarex TAR-H64 Automatics

these rates can be modified by changing the spindle speed or the cycle time. By increasing the spindle speed, or extending the cycle time, the feed rates throughout the machining sequence are reduced, and vice versa. It should be noted, however, if the cycle time is altered in this manner, the fan cams employed for feeding the front slide inwards must be "opened out" or "closed in," to suit the longer or shorter dwell period that is required.

TYPICAL WORKPIECES

In the heading illustration of this article are shown some typical workpieces that have been produced, at the works of a well-known aircraft manufacturer, on Tarex TAR-H machines, operated under the small-batch system. This illustration affords a good indication of the range of component shapes and sizes that can be handled effectively, and in each instance a substantial saving in machining time has been effected, as compared with that required for the previous method. A close-up view of two other workpieces is given in Fig. 10, and working drawings of these pieces are reproduced in Fig. 11.

The part *A* is made from an aluminium-nickel-iron bronze alloy, which is difficult to machine, and a high-quality finish is essential. Spindle speed range No. 4 was used, and change gears to give a standard cycle-time of 775 sec. were fitted, the actual total operation time being 200 sec. (3⅓ min.), Previously, the total time for the production of this workpiece was 14 min. The sequence of operations on the Tarex machine, with the turret station in parentheses, is as follows: (1) feed to stop; (2) idle; (3) rough turn and drill, at a feed of 0·004 in. per rev., with the spindle running at the high forward speed; (4) idle; (5) form the groove and chamfer the inner end of the bore, using a recessing tool actuated from the rear slide, with the spindle running at high-reverse speed, and a transverse feed of 0·0006 in. per rev. applied by means of the variable ratio levers; (6) finish bore, with a feed of 0·0017 in. per rev., and the spindle running at the high reverse speed: copy-turn from the front slide, at the same spindle speed and feed rate; part off with a tool in the vertical slide, with a feed of 0·0012 in. per rev., and the spindle running at the high forward speed. It may be pointed out that boring could have been carried out from the fourth turret station, but was performed after internal grooving in order that any burrs produced during the latter operation should be removed by the boring tool.

A particularly high finish is specified for the part that is indicated at *B* in Fig. 11, and, originally, this was achieved by several finishing and blending operations. On the Tarex machine, the required finish is obtained by single-point copy-

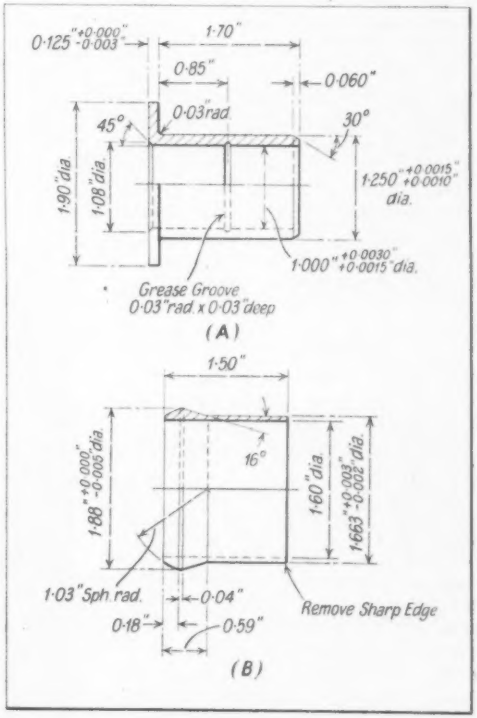


Fig. 11. Details of the Components in Fig. 10 are Here Shown. The Part *A* is Made from an Aluminium-nickel-iron Bronze, and the Part *B* from 35/45-ton Steel

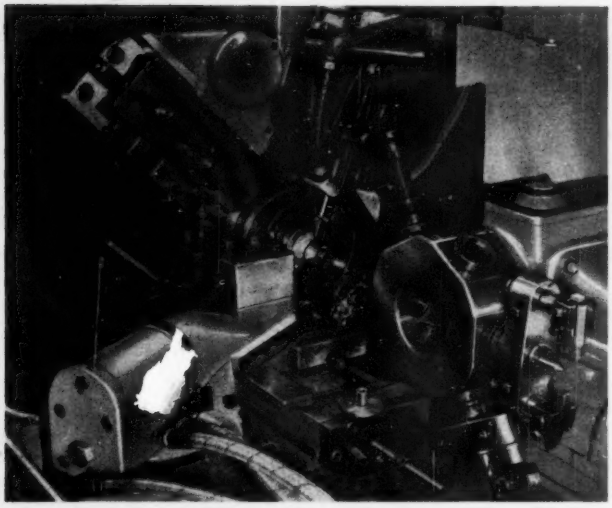


Fig. 12. The Set-up for Producing the Workpiece Seen at the Lower Left in the Heading Illustration. The Hydraulic Copy-turning Unit on the Front Slide is of an Earlier Type which has been Superseded by a Later Design

turning, and the workpiece, of S.1 steel, is completely machined in 390 sec. (6½ min.), as compared with the previous time of 19 min. Again, spindle speed range No. 4 is used, and the sequence of operations is as follows, with the turret positions indicated in parentheses: (1) feed to stop; (2) idle; (3) drill and rough turn, at a feed rate of 0·004 in. per rev., with the spindle running at the high forward speed; (4) rough bore, at the same spindle speed and feed rate; (5) idle; (6) finish bore, at the same spindle speed and feed rate; copy-turn from the front slide, at a feed rate of 0·0017 in. per rev., and the spindle running at the high reverse speed; and part off with a tool in the vertical slide, at the same spindle speed, and a feed rate of 0·0009 in. per rev., obtained by means of the adjustable ratio levers.

During the idle stages of both operation sequences, the camshaft accelerator was engaged to by-pass the unused lobes on the turret cam. The batch quantity for the bronze part was 58, and for the steel part, 89.

SETTING OPERATIONS

Setting-up on the Tarex machines is greatly facilitated by the provision of calibrated trip drums and scales for all adjustable members. In consequence, the correct positions of the various trips, ratio levers, and slides can readily be determined, and recorded for future reference. The tool-holders are held in the turret by means of collet-type clamping members, to ensure concentricity and eliminate bruising of the shanks. Provision is made on the principal tool-holders for setting the tools approximately in their correct positions before they are mounted in the turret.

In Fig. 12 is shown the set-up for producing the

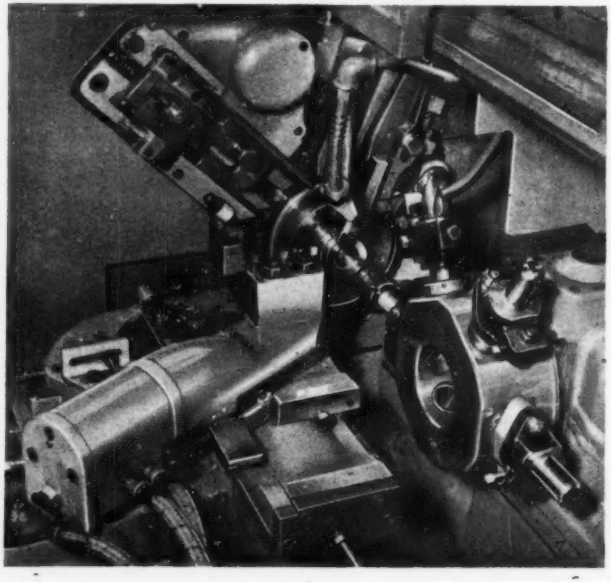


Fig. 13. The Workpiece Seen at the Right in the Middle Row of the Heading Illustration is Produced with this Set-up on a Tarex TAR-H64 Automatic

part seen at the lower left in the heading illustration. The hydraulic copy-turning unit fitted to the machine used for this component is an old type, and has now been superseded by an improved design. The operation sequence comprises feeding to a turret stop; centre drilling and rough turning with balanced knee-tools in the combination holder C; drilling and semi-finish turning from the turret; copy-turning from the front slide; and parting off from the third slide.

When the batch of these parts had been completed, the machine was re-set to produce the workpiece seen at the right of the middle row in the heading illustration. The set-up for this piece is shown in Fig. 13, and the operations comprised feeding to a turret stop; rough turning and drilling, with tools in a knee holder; rough boring; finish boring; copy-turning from the front slide; and parting off by means of a tool mounted on the third slide.

The setting operations included stripping off all existing tools; changing over from normal feeding to outside feeding; changing the collet; changing speed and feed pick-off gears; re-setting the copy-turning attachment; and producing several trial workpieces to enable the positions of the various tools to be checked and finally adjusted. All these operations were carried out by the usual machine setter, and the time that elapsed from the completion of one batch of pieces to the start of the next batch was 1 hour 20 min.

FABROID SELF-LUBRICATING BEARINGS, which have been introduced by the Micro-Precision Division of the Micromatic Hone Corporation, U.S.A., are lined with Teflon tetrafluoroethylene fibre. Self-aligning spherical bearings of this type are now being used in landing gear door strut sections on several types of U.S. military aircraft. It is anticipated that they will also be employed, for example, for control actuators for ailerons and stabilizers, landing gear actuators, and helicopter rotor hub parts.

The face of the bearing is of woven Teflon (a product of the Du Pont Company), and the back-up layer is of woven glass fibre impregnated with phenolic resin, the two layers being interwoven.

Under load, the outside surface of the ball becomes coated with Teflon, so that relative movement takes place between two Teflon surfaces, and frictional resistance is very low. It is stated that these bearings have a wear life up to 10 times that of the normal type, and are suitable for an operating temperature range extending from −75 to 400 deg. F.

Stacatruc Type 624D Fork Lift Truck

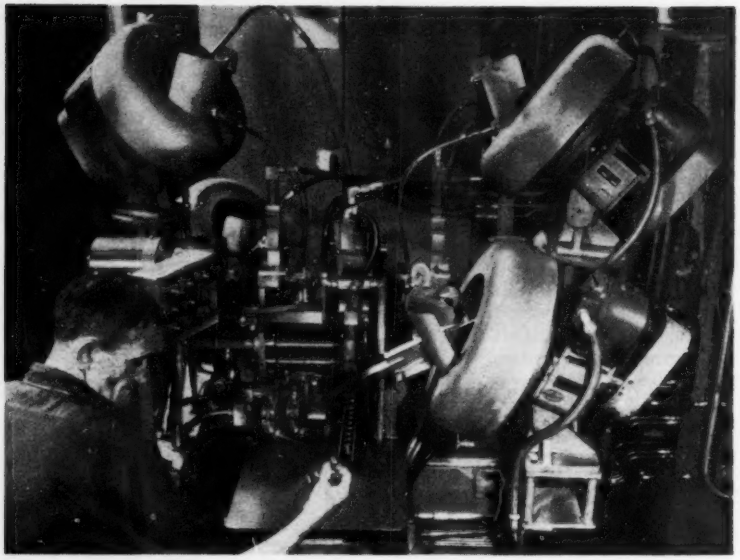
The accompanying illustration shows a recent addition to the range of Stacatruc fork lift trucks marketed by I.T.D., Ltd., 95-99 Ladbroke Grove, London, W.11. Designated type 624D, this truck will handle loads up to 7,000 lb. with the centre of gravity at a distance of 18 in. from the base of the hydraulically-operated 42-in. long forks, and it can be supplied for lifts of 6, 9, 12, or 14 ft.

Drive to the road wheels is taken from a B.M.C. 3·4-litre diesel engine through oil-immersed disc clutches and a constant-mesh gearbox, whereby

Stacatruc Type 624D Fork Lift Truck

two forward speeds of 6 and 10 m.p.h., and a reverse speed of 5 m.p.h., are obtained. The clutch for a particular speed is engaged and disengaged by hydraulically-operated pistons, which are controlled by means of a lever on the steering column. When the lever is set in one of the "drive" positions and the engine is running at idling speed, the appropriate clutch plates are held lightly in engagement so that slip occurs. Acceleration of the engine causes oil pressure on the pistons to be increased with the result that the clutch plates are brought into close contact to provide a positive drive. With this arrangement, the need for a clutch for operation by the driver is eliminated, and the travelling motions are controlled by a 2-pedal arrangement.

Centrally pivoted, the steering axle gives an outer turning radius of 87 in., and it can be provided with a power steering unit, if required.



Quantity Production of Needle Roller Bearings

In the chassis parts manufacturing plant of Ford Motor Co. in Sterling Township, near Detroit, U.S.A., there are many striking examples of advanced production techniques. About 1,340 (long) tons of raw material in the form of forgings, castings, bar stock, and sheet steel are used per day to produce newly designed, more complicated motor car parts in greater volume and with improved quality.

Complete rear-axle and differential assemblies, drive shafts, and ball-joint front suspension assemblies are among the components shipped to 20 Ford car and commercial vehicle assembly plants in 14 states. One of the smallest—yet extremely important—assemblies produced is the universal-joint needle bearing. Severe service requirements—the transmission of the full engine horse-power to the rear wheels—necessitate close tolerances and exacting quality standards. In view of the fact that eight bearings are required per car, moreover, very large quantities must be produced.

Output of these needle bearings has been increased by the introduction of a cold-extrusion operation, followed by automated machining and assembly.

Races are made from hot-rolled, pickled, and oiled SAE 1010 steel. Slugs are blanked, 11 at a time, from 12-in. wide by 10-ft. long and 0·385-in. thick steel sheets, on a Verson 400-ton press, operating at 20 strokes per min. The blanking punch diameter is 0·990 in. and the die diameter 1·090 in. Prior to extrusion, the slugs are washed, pickled (to roughen the surface), and coated with a film of dry lubricant. This Parker Rust-Proof Co. process involves a hot caustic wash, a hot rinse, an acid pickle, a cold rinse, a hot rinse, Bonderite treatment, another cold rinse, a Parcolene rinse, application of the lubricant by dipping in a liquid, and draining.

COLD-EXTRUSION OF THE BEARING RACES

Races are cold-extruded on the Bliss 200-ton press seen in Fig. 1, which operates at 35 strokes per min. and is equipped for magazine feeding and automatic unloading. The operator merely keeps the vertical tubular stacker on the front

of the press loaded with slugs. A pusher arm, actuated by an air cylinder of 2½-in. diameter bore and 2-in. stroke, slides a slug from the bottom of the stack at each stroke of the press. A horizontal line of 14 slugs extends between guide plates from the stacker to the die. As each slug is fed from the stacker, the slug at the opposite end of the line is pushed into the extruding position between spring-loaded fingers.

A sectional view of the cold-extrusion die is shown in Fig. 2. The extruding punch *A* is made from high-speed steel (SAE D-2), hardened to about 61 Rockwell C and ground. This punch is secured to the upper die-shoe by a retainer ring *B* and backed up by a plate *C*, made from an oil-hardening tool steel and having a hardness of 61 Rockwell C. The draw-ring *D* is also made from high-speed steel and hardened to 61 Rockwell C. It is mounted on a support member *E* and back-up plate *F*, both made from oil-hardening tool steel and having a hardness of 59 Rockwell C.

The draw-ring is secured to the lower die-shoe by clamp ring *G*. A knockout pin *H*, made from high-speed steel and hardened to 59 Rockwell C, rests on a spring-loaded bottom punch *K*. Pressure pins *L*, made from cold-rolled steel, are cut to length at assembly to give ¾ in. of "lost motion" before the punch *K* and pin *H* eject the completed extrusion. Approximately 60,000 bearing races can be extruded before regrinding is necessary, and the die can be reground about six times before it need be replaced.

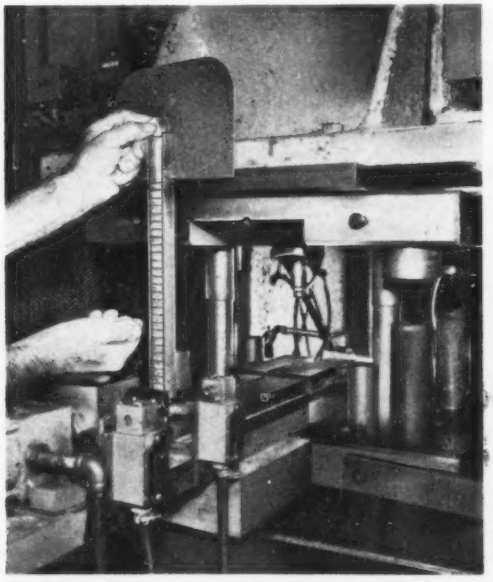


Fig. 1. Races for Needle Bearings are Cold-extruded from Slugs on this Magazine-loaded, 200-ton Press at the Rate of 35 per min.

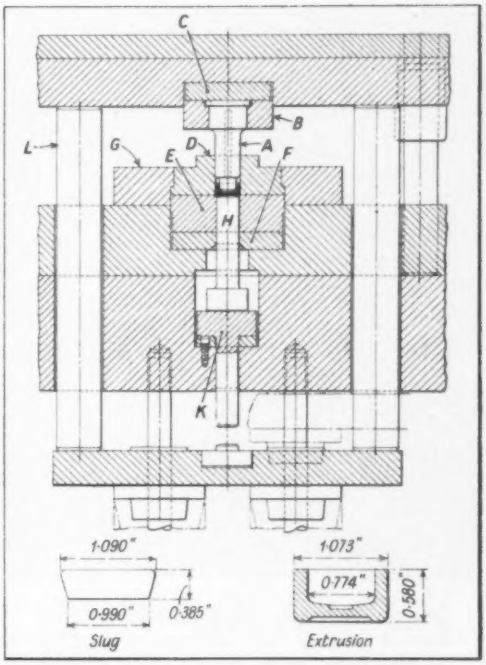


Fig. 2. The Cold-extrusion Die Employed on the Press in Fig. 1. Enlarged Views of a Slug and an Extrusion are shown Below

All machining operations required on the extruded bearing races prior to hardening are completed on the Acme-Gridley 6-spindle chucking automatic, seen in Fig. 3. Finished parts are automatically ejected on to a chute from the fifth position on the machine, by means of a pusher-bar mounted in the spindle. Simultaneously, an extrusion is loaded into the collet from a Feedall hopper and shuttle assembly, by means of a loader head mounted on the machine slide.

At the sixth position, the bore of the extrusion is chamfered with a tool bit mounted in a knee holder on the main tool-slide. In addition, the periphery is broken down by a form tool in a dovetail holder on the cross-slide. Another form tool in a dovetail holder is mounted on the cross-slide at the first position for machining the external radius. A counterboring tool on the main-slide at this position faces the bottom of the race bore.

L

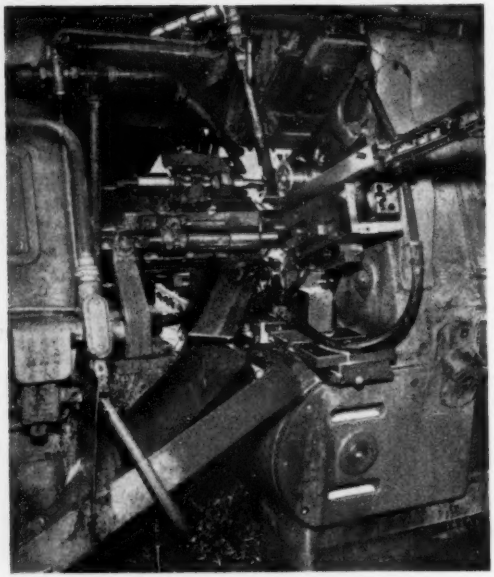


Fig. 3. Extruded Bearing Races Roll Down the Chute at the Right from a Hopper, and are Automatically Loaded in the Collets by a Head Mounted on the Main Tool-slide of this 6-spindle Chucking Automatic

The bottom face is undercut with another main-slide-mounted counterbore at position 2.

An angular fixture and tool-bit are mounted on the main-slide at the third position for recessing the bore. Finally, the bottom face of the bore is finished, and the race is faced to length by means of a counterboring tool on the main-slide at position 4. The workpieces are rotated at 2,156 r.p.m., and the maximum cutting speed is 610 surface ft. per min. The main tool-slide is fed at the rate of 0·003 in. per rev., the form tool at the sixth position at 0·0044 in. per rev., and the form tool at the first position at 0·0022 in. per rev. All tools are tungsten carbide-tipped, apart from the recessing tool, which is of Stellite. The cycle time is only 1·8 sec. and a production of 2,000 bearing races per hour is obtained.

Subsequently, the bearing races are carburized, quenched, washed, and tempered to provide a hardness of 59 to 64 Rockwell C, with a case 0·030 to 0·040 in. deep. Carburizing is carried out in a Surface Combustion controlled-atmosphere, continuous rotary furnace. Heat-treatment is completed in a 10-hour cycle.

RACES ARE GROUND AUTOMATICALLY

About 0·010 in. of stock is removed from the outside diameter of the races by passing the parts through three Cincinnati centreless grinding

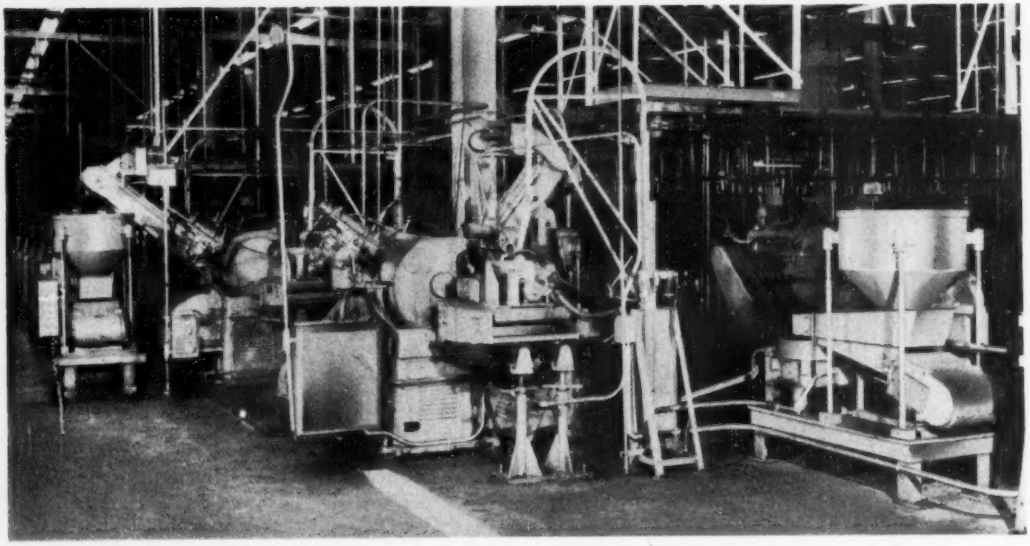


Fig. 4. The Outside Diameter of the Race is Reduced to 1·0630/1·0633 in. during Three Successive Operations on Centreless Grinding Machines

machines, seen in Fig. 4. Approximately 0·005 in. of stock is ground off in the first machine, and the same amount in the second. The third pass provides merely for cleaning up and sparking out. A tolerance of 0·0003 in. is maintained at this operation, the races being ground to an outside diameter between 1·0630 and 1·0633 in. The KDI automation equipment shown in Fig. 5 is employed for loading the centreless grinders automatically, and transferring the parts between successive machines.

Bryant internal grinding machines, one of which is seen in Fig. 6, are employed to finish the bores of the races to a diameter between 0·7845 and 0·7855 in., and remove 0·0095 to 0·0125 in. of stock. Simultaneously, the bottom face of the bore is "bump-ground," a maximum of 0·004 in. being removed from this surface. The minimum diameter of the bore must be within 0·170 to 0·230 in. of the open end of the race, so that the form is slightly crowned, and a surface finish of 16 micro-inches is specified. In addition, the bore must be concentric with the periphery within 0·001 in. total indicator reading.

Races are distributed to the 11 internal grinders by KDI automation equipment and chutes. At each machine, a pick-up arm with loading fingers swings the workpieces into position, one at a time, and loads them into the chuck. Location is controlled by the swinging arm, which loads the races to a pre-set depth, and no positive stop is provided. Ground parts are automatically ejected on to an unloading chute. Each of these grinding machines will complete 290 races per hour.

The outside rear faces of the races are rough- and finish-ground on the Blanchard double-spindle machine shown in Fig. 7. The parts are automatically loaded on to split plug locators mounted on the magnetic chuck of the machine. From 0·006 to 0·010 in. of stock is ground from the surface, and the distance from the inner back face (thickness) is held to limits of ±0·0005 in. The races are automatically unloaded as they pass from beneath the finish-grinding wheel.

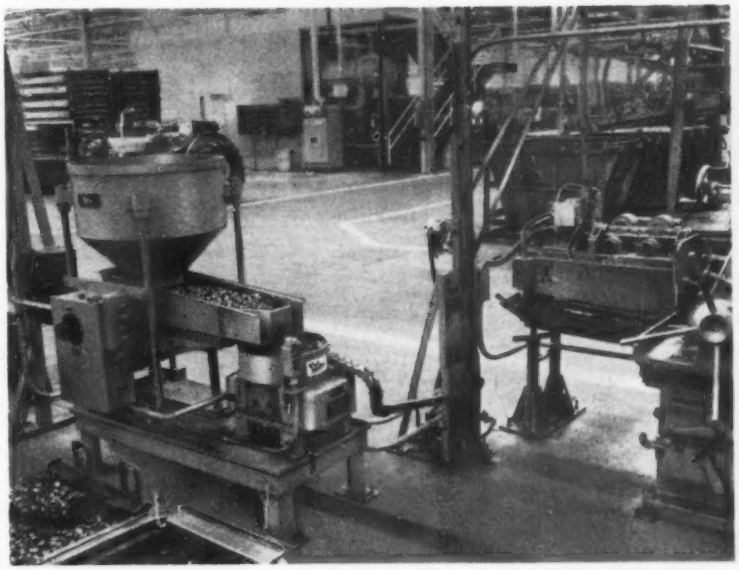


Fig. 5. For Automatically Loading the Centreless Grinding Machines Vibratory Hoppers, Chutes, and Elevating Units are Employed. In this Illustration, the Grinding Machine is on the Right

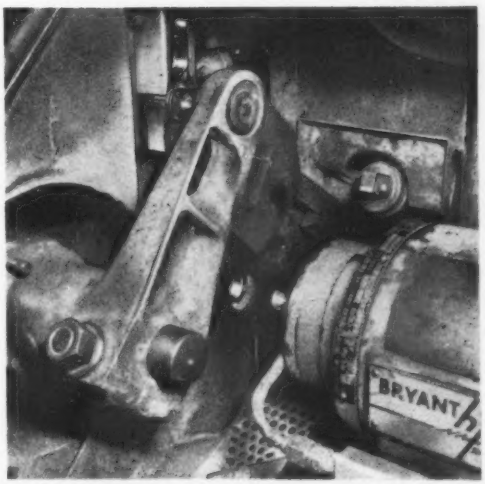


Fig. 6. A Pivoting Pick-up Arm Transfers the Bearing Races, One at a Time, from the Vertical Magazine (top) to the Chuck of this Internal Grinding Machine

For finish grinding the front, open-end faces of the races, a Blanchard single-spindle machine is employed, the parts being automatically loaded directly on to the rotary table. From 0·003 to 0·015 in. of stock is removed at one pass. Completed races are automatically unloaded and fed through a demagnetizer and washer. After final inspection, the races are ready to receive the needle rollers.

AUTOMATIC ASSEMBLY OF ROLLERS AND DUST CAPS

Completely automatic assembly of 23 of these rollers and a synthetic rubber dust cap to each race is accomplished on machines of the type seen in the heading illustration, which were made by Trio Tool Co. Some details of the machine are shown in the sectional views in Fig. 8, and the close-up view, Fig. 9. Needles are held against the race by a film of grease applied to the surface prior to the assembly operation. Each machine has four rotary-type hoppers comprising two upper hoppers for feeding needles; a front lower hopper for caps; and a rear lower hopper for races.

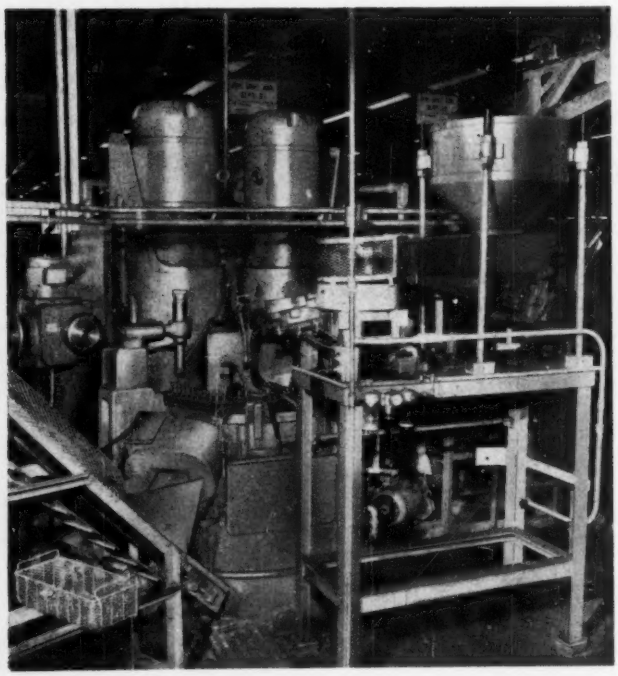


Fig. 7. Needle Bearing Races are Automatically Loaded on this Double-spindle Machine which Rough- and Finish-grinds the Outer Rear Face to Maintain Thickness Limits of ± 0·0005 in.

After being dumped into the hopper at random, races are automatically selected with the open side facing upwards, and are fed down a chute into the first station of a hydraulically-operated transfer bar. When a race has been transferred to the second station, a predetermined amount of grease is applied to the bore. This is accomplished by means of a metering valve and nozzle assembly mounted on a hydraulically-operated slide, which is automatically lowered into position and retracted, as required. When the assembly is in position, the valve opens, and a measured amount of grease is forced through a series of holes in the nozzle.

Station 3 of the automatic assembly machine is idle to permit access to the needle loading mechanism at station 4. To reduce the cycle time, two needle-collection and assembly units are provided, which function alternately.

From the hopper, needles slide down two plastic tubes *A*, seen in Fig. 8, and enter bushes *B* in a jaw-retainer plate *C*. A multiple-lobe cam-ring *D*, driven by a belt and pulley from a geared motor unit, periodically moves two spring-loaded, pivoting jaws *E* outwards, so that needles are permitted to drop into the jaws. When the cam lobe passes and the jaw returns under spring pressure, a needle drops into a hole in the cam-ring.

Needles in the cam-ring are free to drop into an escapement ring *F*. When the latter is filled, and two additional sets of needles have been loaded into the cam-ring, the pawls *G* (secured to the bottom of the jaws) contact the needles in the top of the cam-ring and prevent the jaws from closing. When this happens, one or both jaws idle in the open position until the top row of needles in the cam-ring has been lowered.

To release a set of 23 needles from the escapement ring, the hydraulic cylinder *H* is actuated. On the down stroke, a collar *T* on the piston-rod *K* over-rides a one-way dog *L* on the brake-slide *M*. On the up stroke, this collar strikes the dog, thus advancing the brake-slide and stopping the rotation of the escapement ring momentarily.

The needles then slide down holes drilled at an angle in the collection pulley assembly *N*, and fall into positions around a grooved arbor *V*. The rubber O-ring *P*, mounted on the

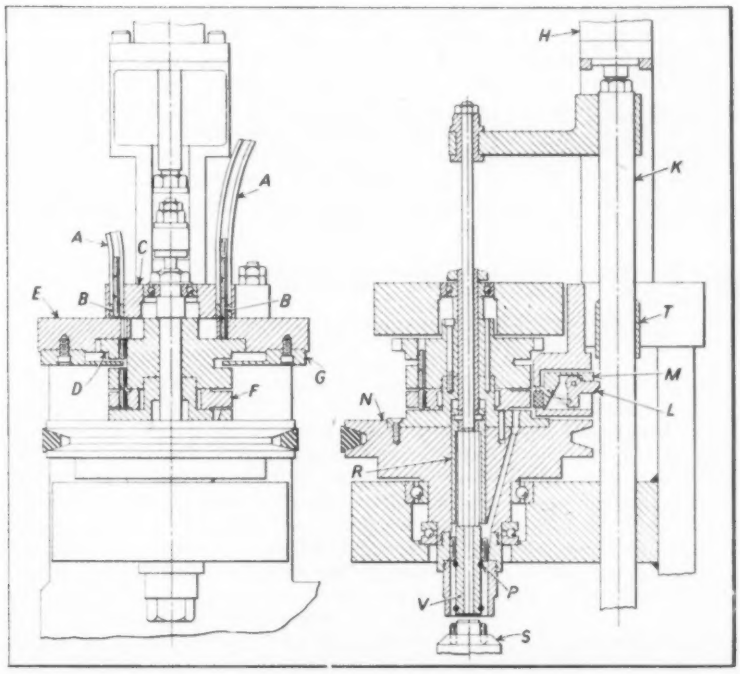


Fig. 8. Front and Side Sectional Views of One of Two Identical Needle-collection and Assembly Units Employed on the Bearing Assembly Machine

arbor, prevents the needles from falling out. During the next down stroke of the cylinder, the assembly sleeve *R* pushes the needles past two O-rings, and into the assembly collet S. Then, on the up stroke, another set of needles is deposited in the grooved arbor, ready for the next cycle. Near the top of the stroke, the collar *T* releases the brake-slide *M* and permits the escapement ring *F* to return to its normal position (with the holes aligned with those in the cam-ring *D*).

While one assembly collet is being loaded with needles, the second collection and assembly unit is over the transfer bar. A hydraulic motor rotates a dual cam which contacts two followers on the assembly collet. These followers are attached to plungers within the collet, and, as the cam rotates, the plungers load needles into the race.

When the next race has been transferred to the third station, the empty assembly collet is indexed by turning it through 180 deg. to a position beneath the second needle-collection unit. Simultaneously, the loaded assembly collet that was under the other needle-collection unit is positioned over the race to be filled.

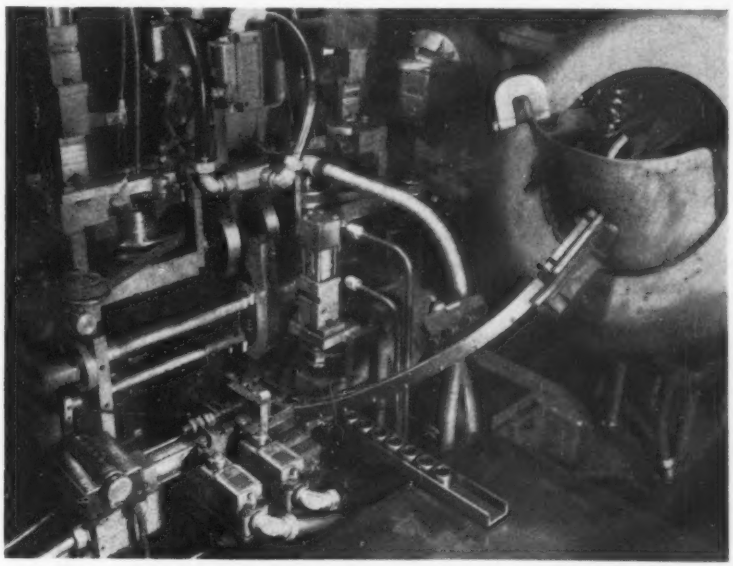


Fig. 9. (below) Close-up View of the Unloading End of the Machine for Automatically Assembling Rollers and Dust Caps to Bearing Races

This turn-over indexing movement is effected by a hydraulic shuttle mechanism, with upper and lower shuttle bars which move at different speeds. This speed difference is determined by the ratio between the driving and driven gears in a gear-box between the two bars.

Station 5 of the automatic assembly machine is also idle to permit access to the needle loading station. At the sixth station, seen at the bottom centre in Fig. 9, the synthetic rubber dust caps are assembled. Caps are automatically selected from the hopper in the required position and fed down a chute into a loading slide. This slide reciprocates to locate each cap over a bearing race, and a hydraulically-actuated, vertical plunger presses the caps over the races. At the next forward motion of the transfer bar, the completed needle bearing is pushed into a discharge chute.

Stahl Elektus Conveyor and Work Loading Equipment

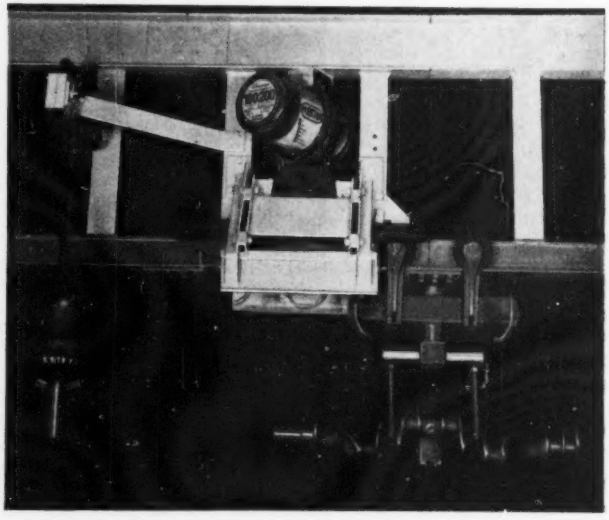
Shown in the figure is a close-up view of part of the German-made Stahl Elektus conveyor and work loading equipment for which Verrolec, Ltd., Balfour House, Finsbury Pavement, Moorgate, London, E.C.2, are the selling agents in this country.

With this system, trolleys for supporting workpieces are moved by hand on an inverted T-section track, which is suspended by vertical members from an overhead beam. At positions where loading of workpieces on to machines, for example, is to be carried out, electric hoists are attached to the beam, and are connected to short detachable portions of the track.

For the loading operation, a trolley carrying a workpiece is moved on to the detachable section of the track, and is then automatically held by means of a pawl. Next, the hoist is brought into use, by means of the manual controls provided, so that the detachable part of the track—and with it the trolley and its associated workpiece—is lowered. During the first part of this movement, horizontal bars, incorporated in inclined side pieces, are lowered in order to prevent other trolleys from being accidentally moved, from either direction, on to the detachable part of the track, at the loading position.

When the detachable part has been returned to its upper position at the end of the loading operation, the pawl is automatically released, and the side bars are moved clear. The trolley can then be moved freely on the track and a fresh trolley can be brought to the loading position. By the same procedure, an unladen trolley can be brought to the lowered position to receive a workpiece which has been unloaded at the end of the machining cycle.

Each trolley will support a maximum load of 6 cwt. Since the trolleys are moved freely on the track, banks of components can be readily stored between machines at convenient points in a production line. With this arrangement, when one machine in a line is stopped for tool changing, for example, operation of the remainder need not be interrupted.



Close-up View of Part of a Stahl Elektus Conveyor and Work-loading Installation Showing One of the Electric Hoists, and a Large Crankshaft Suspended from a Work-carrying Trolley

New Production Equipment

Town Duplex 6-ft., Bogie-type, Girder Radial Drilling Machine

Fredk. Town & Sons, Ltd., Mile Cross Engineering Works, Halifax, have recently built the duplex, 6-ft., bogie-type, girder radial drilling machine, shown in the figure, for the South African Railways and Harbour Board. It is designed to travel on rails set at 13-ft. centres, and the centre-distance of the columns is 7 ft. There is a clearance of 12½ in. between the bridge and the rails, the maximum distance from the spindle nose to the top of the rails is 30 in., and the maximum and minimum radii of the spindles are 73 and 17 in. Holes up to 2 in. diameter can be drilled from the solid, in mild steel. The spindles are of high-tensile steel and are carried in hardened steel quills, which provide support when they are extended to the maximum traverse of 15 in. Ball thrust bearings are employed to take the drilling loads, and compensating springs enable the spindles to be adjusted rapidly. The feed movement is transmitted by a pinion which meshes with rack teeth cut in the periphery of the quill.

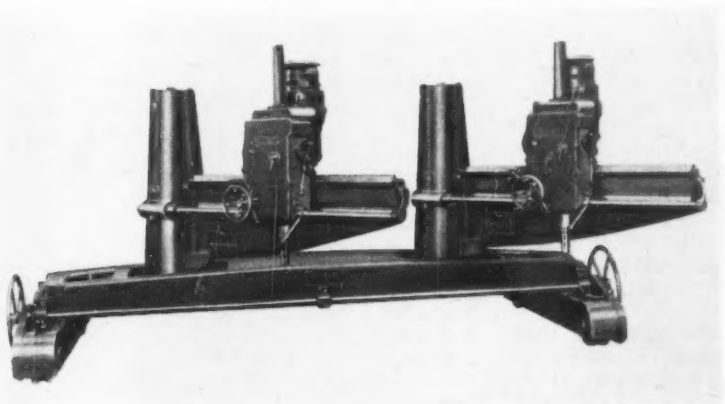
Machines with four spindle speeds, ranging from 160 to 600 r.p.m. have spindles bored No. 4 Morse taper, and those with eight speeds, from 20 to 500 r.p.m., have spindles bored No. 5 Morse taper. Three rates of power feed are provided, ranging from 60 to 120 cuts per in., and changes of feed rate can readily be effected without stopping the machine.

A pump, housed in the saddle, provides for the lubrication of the driving gears, and the feed wormwheel runs in an oil bath.

Drive to the spindle is taken from a 5-h.p. vertical motor mounted on top of the saddle, and when the machine is required for tapping, in addition to drilling, a rapid-reversing motor is fitted, which is controlled by a drum switch.

The saddle is traversed along the arm on ball-bearing rollers, and a single adjustable lever serves to lock the saddle on the arm, and the arm to the column, simultaneously. Ball bearings are provided for the radial arm, to ensure easy rotation on the column, and collector gear at the top of the latter allows the arm to be swung through 360 deg. without cable interference.

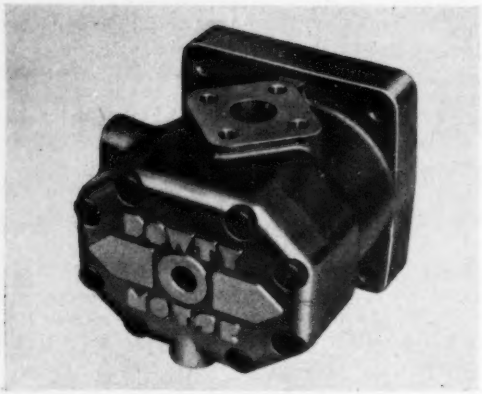
The approximate weight of the machine is 143 cwt.



Town Duplex 6-ft. Bogie-type Girder Radial Drilling Machine

Dowty Hydraulic Gear Motors

A range of gear-type hydraulic motors, with maximum outputs up to 30 h.p. and speeds from 300 to 3,000 r.p.m., one of which is shown in the accompanying illustration, is now available from Dowty Hydraulic Units, Ltd., Ashchurch, Gloucestershire. These motors are of basically similar design to the



An Example from the New Range of Dowty Hydraulic Gear Motors

Dowty gear pumps, and the same method of internal pressure balancing is employed. Inlet pressure is applied to the outer ends of the bushes in the pump cartridge, and O-ring seals are employed to limit the area on which the pressure acts. By this means, a controlled force, which is slightly greater than the load tending to separate the bushes, is applied to maintain the latter in contact with the gears. Consequently, the clearance is reduced to the minimum required for lubrication, and internal leakage is prevented.

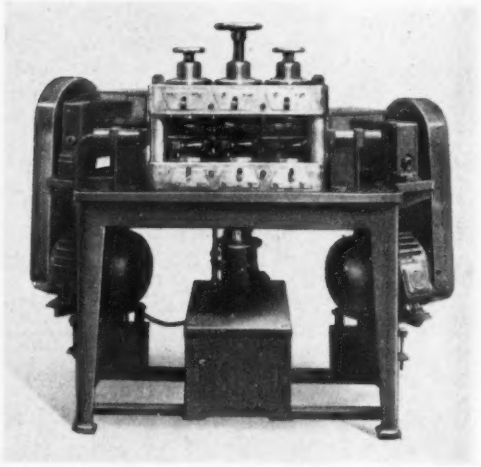
The gears are mounted on plain bearings, and each bearing is lubricated by a metered flow of fluid, which is subsequently returned to a connection in the cover of the motor. These motors are suitable for flange or foot mounting, and a range of pipe connections is also available.

Bronx Multiple Cross-roll Tube Straightening Machine

The multiple cross-roll, tube straightening machine shown in the accompanying illustration is made by the Bronx Engineering Co., Ltd., Lye, Nr. Stourbridge, Worcestershire. Nickel-alloy steel tubes up to ½ in. diameter by 0·036 in. wall thickness can be straightened on this machine, at a speed of 120 ft. per min. Straightening is effected by profiled line contact rolls, each of which is driven.

There are two banks, each comprising three rolls, and those in the upper bank are mounted in quills which may be adjusted vertically to accommodate various diameters of tube. In the lower bank, the central roll only is arranged for vertical adjustment. When setting the machine, the outer rolls in the upper and lower banks are adjusted to suit the diameter of tube to be straightened, and the central rolls in each bank serve to produce the working deflection. An individual angular adjustment is provided for each roll, to facilitate setting for line contact with the tube. Indicators register all vertical and angular adjustments.

The straightening rolls are made from hardened alloy steel and are mounted on roller bearings. A totally-enclosed gearbox, driven through V-belts by a 1½-h.p. motor, is provided for each bank of rolls. Universal couplings and shafts are employed



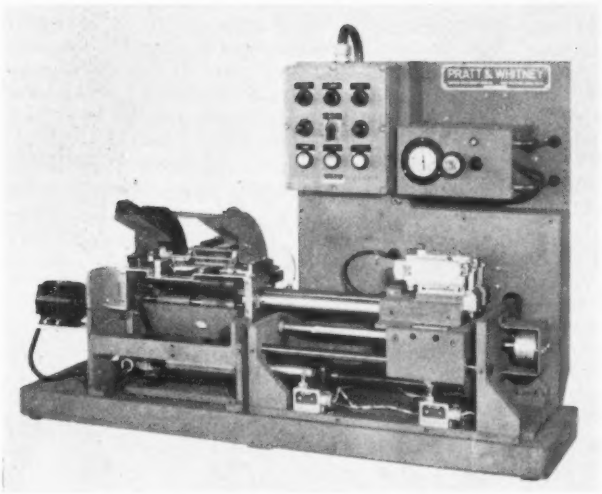
The Bronx Multiple Cross-roll Tube Straightening Machine

to connect the gearboxes to the rolls so that angular and vertical adjustment of the latter may be accommodated. The machine frame is of welded steel construction.

Pratt & Whitney Automatic Gauging Machine for Tubular Parts

The automatic gauging machine shown in the illustration has been built by Pratt & Whitney Co., Inc., West Hartford, Conn., U.S.A., for checking light-alloy tubular parts, which are closed at one end, for wall and base thickness. It will handle workpieces at the rate of 1,000 per hour.

Components are fed down a chute on to an arrangement of rubber rolls, which are driven at a

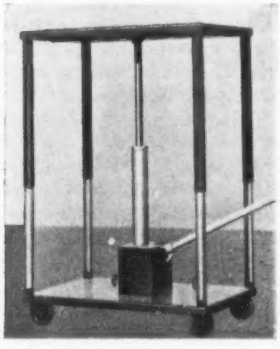


Pratt & Whitney Automatic Gauging Machine for Tubular Parts

speed of approximately 600 r.p.m. As the work is rotated, a gauging head is passed through the bore for checking the wall thickness. At the end of the travel, the base is checked for thickness, and the gauging head is then returned to its starting position at increased speed. Sigmatic Microlimit gauge heads are then operated, which cause the component to be discharged on to one of three conveyors, for acceptable, rectifiable, and reject pieces.

The selling agents in this country for the Pratt & Whitney Co. are Buck & Hickman, Ltd., Otterspool Way, By-Pass, Watford.

Farrow & Jackson Elevating Trolley



Farrow & Jackson Elevating Trolley

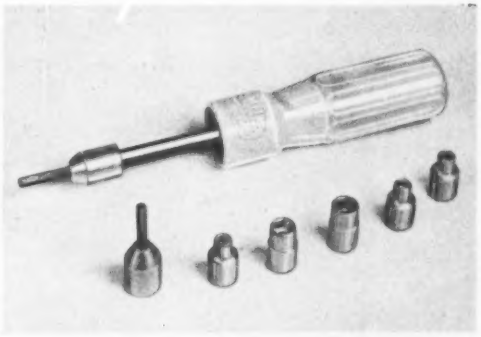
Marketed by Farrow & Jackson, Ltd., 41/42 Prescot Street, London, E.1, the hydraulic elevating trolley, here shown, enables loads up to 8 cwt. to be raised by hand to a maximum height of 4 ft. in 35 sec., for loading on to the floors of lorries, for example.

For lowering the 33- by 21-in. table top automatically, to the minimum height of 29 in., the operating lever is turned through a half circle in the anti-clockwise direction. Table tops in such materials as stainless steel, incorporating various work-locating and roller-conveyor arrangements, can be supplied to order.

Two of the trolley wheels can swivel to facilitate manœuvring.

The M.H.H. Torquemaster Torque-limiting Screwdriver

A torque-limiting screwdriver, which can be pre-set to any specified loading between 8 oz.-in. and 35 lb.-in., has been developed by the M.H.H. Engineering Co., Ltd.,



The M.H.H. Torquemaster Torque-limiting Screwdriver

Bramley, Guildford, Surrey, and, with various socket bits, is shown in the accompanying figure. Known as the Torquemaster, this tool incorporates an adjustable precision ball-clutch mechanism, and the ¼ in.-square drive spindle will accommodate any form of nut socket, or screwdriver bit. A ball-thrust bearing takes the end-thrust, and the spindle is mounted on ball bearings. The operating cam has three equally-spaced lobes, so that one-third of a turn only is required for re-setting the tool.

An accuracy of ±1 oz.-in. and ±1 lb.-in. is claimed for torque settings of 8 oz.-in. and

35 lb.-in., respectively. Setting rigs for ranges from 0 to 10 lb.-in., graduated in ½-oz. divisions, and from 0 to 50 lb.-in., graduated in 2-oz. divisions, are also available.

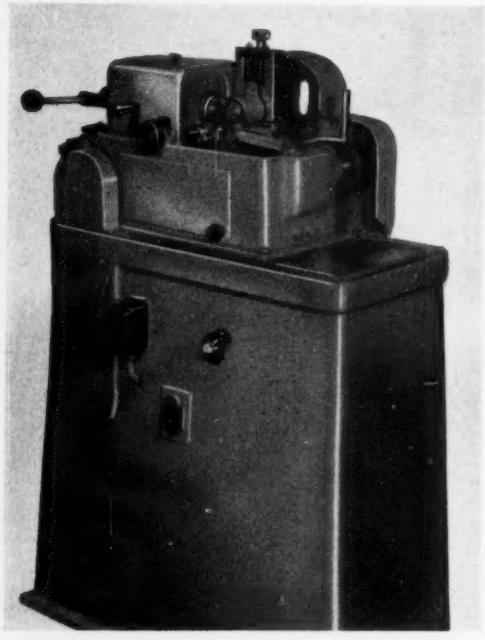
The Torquemaster has a plastics handle of 1¾-in. diameter, an overall length of 6¾ in., and a weight of 9 oz.

Greiner & Jacoby Indexing Milling Machine

Fenter Machine Tools, Ltd., 184 Aston Road, Birmingham, 6, are the selling agents in this country for the German-made Greiner & Jacoby indexing milling machine shown in the illustration.

Designated type 24/36, this machine is semi-automatic in operation, and enables lengths up to 1 7/16 in. to be milled with the horizontal feed of the work-head spindle, and up to ⅞ in. with the vertical feed of the cutter head. Collets up to 13 mm. (0·512 in.) capacity can be fitted to the workhead spindle. Alternatively, a 3-jaw chuck and a steady for long components can be provided, and parts up to 1 3/16 in. diameter may then be handled.

Drive is taken from a 2-speed pole-changing motor of 1·5/0·75 h.p., housed in the base, through V-belts and stepped pulleys to the cutter spindle, and through worm gearing for the feed and indexing motions. Twelve spindle speeds from 510 to 5,140 r.p.m. are provided. Horizontal feed is imparted to the work spindle by a cam mounted on the worm shaft, through a pivoted guideway member and a radially-adjustable slider, and thence by a segment gear and rack teeth. With this arrangement, different spindle travels with feeds from 0·001 to 0·02 in. per rev. can be obtained. During the working stroke, cutting fluid is delivered to the work, and a smooth feed motion is ensured by the action of a dashpot cylinder which is mounted at the left-hand end of the bed and is connected to the work-head spindle.



Greiner & Jacoby Indexing Milling Machine

The indexing motion of the work-head spindle and vertical feed of the cutter head are derived from separate cams mounted on the wormwheel shaft. From one of these cams, motion for indexing is transmitted through a push rod and bevel gearing to a vertical rack in mesh with a wide gear which surrounds the workhead spindle at the rear end. During the return movement of the rack at the end of the indexing cycle, the gear is turned independently of the workhead spindle. With this arrangement, the spindle can be indexed through a maximum angle of 180 deg. Packing pieces are provided for limiting the stroke of the push rod, so that 3, 4, 6, 8, 12, and 24 indexing positions can also be obtained. While milling is in progress, the workhead spindle is located, positively, by a pin which engages with an index plate.

An adjustable trip mechanism is incorporated which operates a limit switch for stopping the driving motor at the end of the working cycle. To facilitate loading and unloading workpieces, the entire cutter spindle and column assembly is moved clear on cross guideways at the rear of the bed by means of a lever. The collet is then opened and closed by operation of a second lever on the workhead. This arrangement enables loading and unloading of workpieces to be quickly carried out, and since the working cycle is fully automatic, one operator can readily tend several machines.

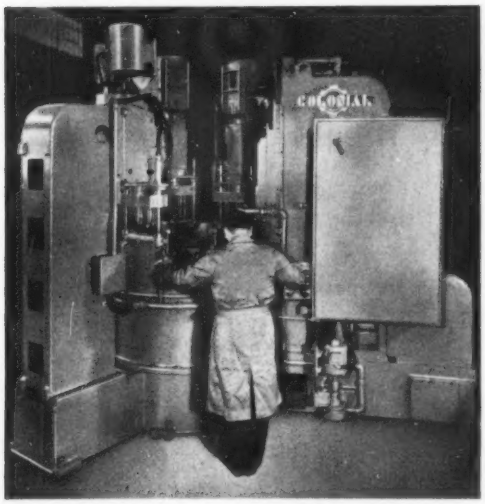
The vertical power feed of the cutter head is primarily intended for milling a flat surface on the work at the end of a plunge-cutting operation with horizontal feed. When the horizontal feed only is to be employed, the cutter head can be adjusted vertically by a screw for setting the depth of cut.

A spring-loaded tailstock is available for attachment to the side of the cutter head, and special

work-holding fixtures can be provided, if required. The machine weighs approximately 6½ cwt., and occupies a floor space of 33 by 18 in.

Colonial 6-Station Drilling and Broaching Machine

The 6-station machine here illustrated has been built by the Colonial Broach & Machine Co., Detroit, Michigan, U.S.A., for performing, at each working cycle, a total of 14 operations on each of two pawl components. In addition to drilling,



Colonial 6-station Drilling and Broaching Machine

reaming, and chamfering, the operations carried out include broaching four surfaces on each component at a single pass. Work loading is carried out by hand, and the machine has an output of 304 finished components per hour at 80 per cent efficiency.

Work-table indexing is effected hydraulically, the motion being controlled by cam-actuated limit switches, which also provide for the operation of the broach-return mechanism. The accuracy of the indexing arrangement is claimed to be such that the work is positioned within 0·0005 in. of the required setting.

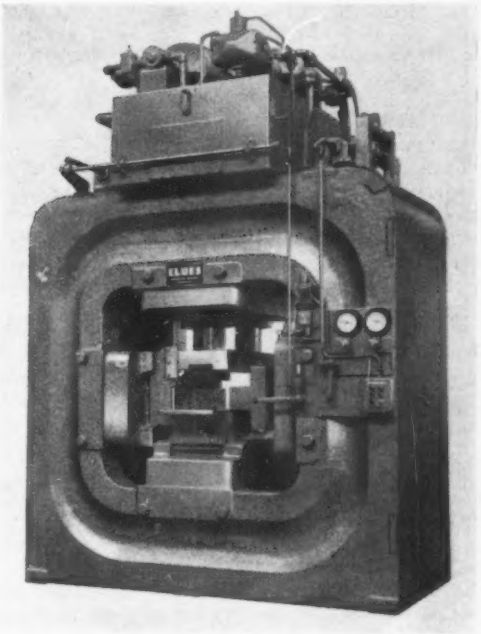
Gaston E. Marbaix, Ltd., Devonshire House, Vicarage Crescent, London, S.W.11, are the selling agents in this country for the Colonial Broach & Machine Co.

Elmes Metal Powder Compacting Press

Elmes Engineering Division, American Steel Foundries, Cincinnati, Ohio, U.S.A., have built the hydraulic press shown in the figure for compacting metal powder. Of steel box-type construction, the press incorporates a 1,000-ton capacity top ram and a 750-ton capacity side ram, which can be controlled independently of each other by means of hand levers. The rams are mechanically interlocked so that, in operation, movement of the top ram is prevented until a pre-determined side load has been exerted, and the load applied can be varied for each ram by hand-operated remote control valves.

During the working cycle, the rams are traversed rapidly for the approach and return movements and at slower speeds for the pressing stroke. Setting is facilitated by a " proportioning " control arrangement for both rams, and during this operation the interlocking unit can be rendered inoperative. Hardened steel reversible wear plates are provided over the die area, which is readily accessible both from the front and rear of the press.

These presses can be supplied with various capacities and die spaces, to suit requirements, and a third bottom ram can be provided to order.



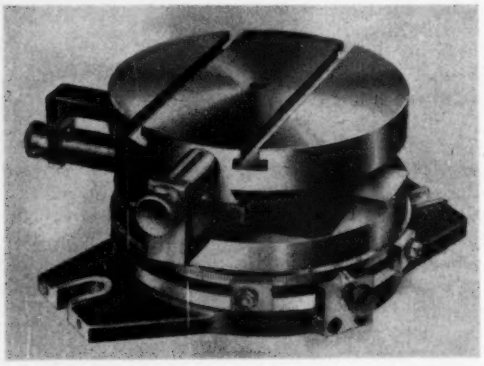
Elmes for Metal Powder Compacting Press

The makers are represented in this country by William Coulthard & Co., Ltd., Durranhill Road, Carlisle.

Woodward Form Tool and Jig Grinding and Wheel Radiusing Unit

Shown in the accompanying illustration is the 8-in. diameter compound rotary table recently introduced by N. F. Woodward, Hazel Drive, Narborough Road South, Leicester.

Originally intended to facilitate grinding operations on form tools with radiused and angular cutting edges, this table may also be used for other purposes, including the drilling of holes at accurate centre distances, die sinking, and grinding various profile shapes. The upper portion is mounted on dovetail compound guideways, and can be adjusted in two directions, at right angles, through a maximum distance of 1¼ in. on each side of the central position, by means of screws. Scales are provided on the setting knobs, which give readings to 0·001 in. This assembly can be turned through a full circle on the base, and adjustable stops are fitted which can be set with reference to a scale for controlling angular movements. A clamping pad, which can be applied by means of a knurled knob, is provided for securing the table assembly to the base.



Woodward Form Tool and Jig Grinding and Wheel Radiusing Unit

Various attachments are available, including a pair of swivel brackets, which can be fastened to the ends of the base by means of screws, and enable the table to be tilted through a maximum angle of 20 deg. in each direction. Scales on these swivel brackets give readings to 2 deg. to facilitate setting. Another attachment permits convex and concave radii to be dressed on grinding wheels. It comprises a bracket to carry a diamond holder, and a setting block, which can be attached to the T-slotted working surface of the table. The setting block, which has a stepped reference surface, is used in conjunction with a button, fitted in a ½ in. diameter hole in the table, for positioning the diamond in line with the axis of rotation. Radial settings of the diamond are then made by movement of the table on one of the dovetail guideways.

Other ancillary equipment obtainable includes a bracket and mandrel assembly and a support finger, which, in conjunction with the rotary movement of the table, enable corner radii to be ground on side and face milling cutters. Alternatively, the support finger and bracket may be used with another attachment, which incorporates a pair of centres, and is intended for holding reamers and end mills during cutter grinding operations. Equipment for holding form tools can be provided.

The table occupies a space of 13 by 13 in., has an overall height of 5¼ in., and weighs 56 lb.

British Indicators Type 16-B Magnetic-base Test Set

A new magnetic-base test set, known as the type 16-B, has been introduced by British Indicators, Ltd., Sutton Road, St. Albans, Herts, and is a development of their previous type No. 16. A magnetic base measuring 2½ in. by 2½ in. by 3 in. is used, which has twice the adhesive power of the smaller size, formerly employed, and as can be seen in the illustration a knurled screw is provided for fine adjustment of the cross-arm. This set can be supplied complete with the Series 2 dial indicator, which may be graduated in 0·001 in., 0·0005 in. or 0·01 mm. divisions.

British Indicators Type 16-B Magnetic-base Test Set

Machine Shop Patents

AUTOMATIC TEMPLATE-CHANGING MECHANISM FOR A COPYING LATHE

In the accompanying Fig. 1 is shown a diagrammatic front view of a copying lathe on which steel templates are used in conjunction with a hydraulically-operated sensing stylus. The workpiece shown at *A*, which has a flange located unsymmetrically in relation to its length, requires two machining operations, and the first of these is about to be undertaken in Fig. 1, the path of the tool being shown by a heavy dotted line and arrows. In the view at *X*, the workpiece is shown reversed for the second operation, the path of the tool being similarly indicated.

A pivoted carrier *E*, in Fig. 2, holds the first- and second-operation templates *F* and *G*. Angular movement of the carrier *E* is obtained from a linkage connected to the piston rod *H* of a single-acting cylinder. Hydraulic oil can be supplied to, and exhausted from, this cylinder by a spool valve, the spool *K* being moved axially by the solenoids *L* and *M*. A cam on the carrier *E* is arranged to operate a reversible switch *P*, and there is a further switch *R* with an associated relay *S*. Integral with the tool slide is a cam *T*, which serves to operate the switch *U*.

A reversible micro-switch *C* is contained by the housing *B*, which is adjustable horizontally along the cross-arm of the machine on guideways (not shown). The switch *C* alternately energizes the solenoids *L* and *M* and is actuated by the vertical movement of the plunger *D*, on the lower end of which there is a freely rotating roller.

In Fig. 2, the electro-hydraulic control system is shown with the various elements in the positions which they occupy just before the start of the first operation, with the template *F* in contact with the stylus, and the spool *K* held in its left-hand position by the spring and lever *V*. As the tool slide advances, the cam *T* permits the switch *U* to open, and the consequent de-energization of the relay *S* opens the switch *R*. While the tool slide is in the working position, therefore, the solenoid *M* cannot be energized by the accidental operation of the switch *C*.

On the completion of the first operation, the tool slide retracts and the cam *T* closes the switch *U*, which energizes the relay *S* to close the switch *R*. When the workpiece *A* is reversed, and loaded for the second operation, the flanged portion contacts the plunger *D*, and by moving it vertically upwards, causes the switch *C* to complete, through its right-hand contact, the circuit necessary to energize the solenoid *M*. The spool *K* is thus moved to the right and oil is exhausted from the head end of the cylinder. The spring-loaded piston rod *H* is now able to move to the right and to impart a clock-wise rotation to the carrier *E*, to bring the template *G* into contact with the copying stylus.

This patent also covers an arrangement for rotating the carrier *E* by means of solenoids,

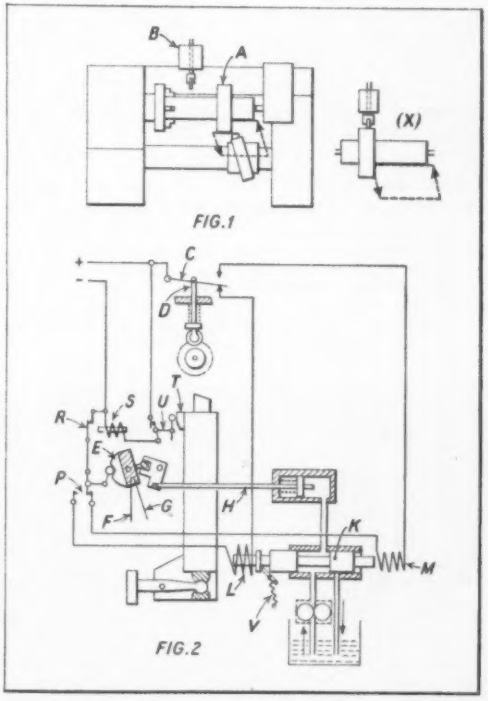


Fig. 1. Diagrammatic Front View of a Copying Lathe Set Up for the First Operation on a Workpiece, which is Reversed for the Second Operation as Seen at *X*

Fig. 2. Diagram of the Electro-hydraulic Control System for Automatic Template Changing on the Copying Lathe

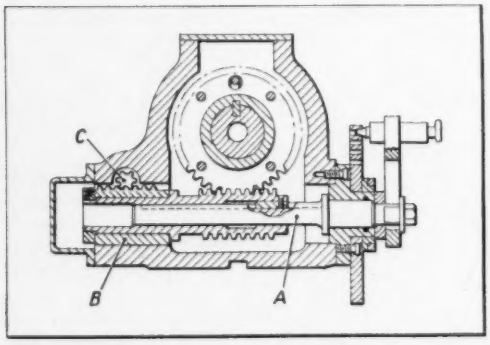
instead of the spool valve and cylinder shown in Fig. 2.

785,516 Georg Fischer Atkiengesellschaft, Schaffhausen, Switzerland. [*Application date, December 7, 1954. Published, October 30, 1957.*]

FINE ADJUSTMENT MECHANISM FOR A DIVIDING HEAD

A cross-sectional view of a dividing head is shown in the accompanying drawing. The conventional worm and wormwheel are employed for rotating the workpiece, the worm being rotated by a lever, which incorporates a spring plunger for engagement in a series of holes in an index plate.

In this design, the worm is keyed to the shaft *A*, but is free to slide axially. The left-hand end of the worm is extended to pass through, and rotate within, the sleeve *B*. A pinion *C* is carried in the dividing head body, and is arranged to mesh with rack teeth cut on the periphery of the sleeve *B*. This sleeve is retained, against a shoulder on the worm by means of a locknut, and rotation of the pinion *C* will move the sleeve, and the worm, axially. In this manner, angular movements of the wormwheel can be added to, or subtracted from, those obtained by rotation of the main indexing lever. A large diameter disc is attached to the



Cross-sectional View of a Dividing Head with Fine Angular Adjustment

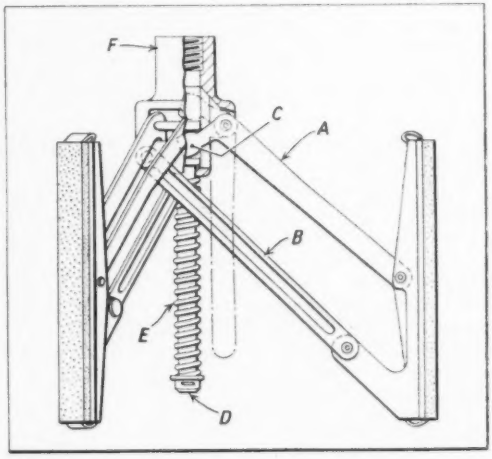
outer end of the pinion *C*, and is graduated on either side of a zero mark. The meshing of the pinion *C* with the teeth in the sleeve *B* prevents the latter from turning when the worm is rotated.

786,746. M. King (Engineers), Ltd., Wellington Road, Uxbridge, Middlesex. [*Application date, November 12, 1954. Published November 27, 1957.*]

A SELF-ADJUSTING HONING TOOL

In the accompanying drawing is shown a self-adjusting honing tool, with three equally spaced carriers for the abrasive stones. Each carrier is mounted on a pair of pivoted, parallel arms, *A* and *B*. As these arms swing about their pivots, the cutting faces of the stones are maintained parallel to the axis of the bore in the workpiece that is being honed.

At the inner end of, and integral with, each arm *A*, there is a short lever *C*, with a radiused



Part Sectional View of a Self-adjusting Honing Tool

end. This lever is forked, and engages with an annular groove in the shaft *D*. A spring *E* thrusts against a washer at the outer end of the shaft *D* and against the body portion *F*. The action of this spring is thus transmitted, through the shaft *D*, to the levers *C*, and tends to move the arms *A*, and consequently the abrasive stones, outwards. The body portion *F* has a tapped hole, to receive a driving shaft.

784,986. Ammco Tools Inc. Chicago, Illinois, U.S.A. [*Application date, April 12, 1955. Published October 23, 1957.*]

PRODUCTION OF DRY SHAVERS in this country, rose from a monthly average of 77,800 in 1954, to 86,000 in 1955, and 113,700 in 1956. During the first quarter of 1957, the average monthly output of dry shavers was 122,200; in the second quarter, 82,000; and in the third quarter, 92,300.

News of the Industry

Manchester and District

MODERATE CALL FOR PIG-IRON.—From the Lancashire foundries there is a fairly steady demand for Derbyshire and Staffordshire common foundry irons. The heavy engineering foundries continue to take reasonably good deliveries in the aggregate, but in the light castings section, where further labour reductions have been reported, there is still ample room for improvement. Jobbing foundry order books do not extend far ahead, and consumption of No. 3 iron is below normal. The call for West Coast haematite pig-iron, also for the various descriptions of finished iron materials, is maintained at about the recent level.

REDUCED DEMAND FOR STEEL MATERIALS.—In many instances, users of steel and stockholders are working down their stocks, with an adverse effect on the volume of new business. For both black and galvanized sheets demand has fallen off, and the rollers are seeking additional orders. Structural steels, particularly in the lighter sections, are also more readily obtainable, and some mills are indicating second-period deliveries against fresh bookings. Heavy plates, however, are still wanted in substantial tonnages. A brisk business is also reported in large-diameter steel bars of 3 in. and upwards, with delivery periods in some instances ranging from 12 to 15 months according to size. Forgemasters, who are still busy for the most part, are finding difficulty in obtaining the requisite supplies of blooms and billets, so that increased working from ingots is necessary. Other users of semi-finished steels, including wire-drawers, maintain a steady call for supplies.

TEXTILE MACHINERY EXPORTS IN 1957.—The Lancashire and Yorkshire textile machinery industry exported equipment during 1957 of a total value of £43,000,00.

TAYLOR INDUSTRIAL CLUTCHES, LTD., Trows Lane, Castleton, have recently provided and occupied new commercial offices. A good demand is reported for pneumatic clutches and brakes for application to forging machines, presses, paper-making machinery, and rubber calenders and mills. The air-operated brakes for the latter plant provide for almost instantaneous stopping to meet safety regulations, and the brakes for presses facilitate operation. A steady call is being experienced for single and duplex multi-plate friction clutches for driving machine tools and general engineering plant, and the field of application is being gradually extended.

L. E. WILSON (DIE CASTING) CO., LTD., Trows Lane, Castleton, are busy with the production of a variety of gravity and pressure die castings in aluminium, aluminium-bronze, and zinc-base alloys. Work is in progress for the electrical engineering, flour-milling machinery, textile machinery, general engineering, and motor car industries. The firm's toolroom is working at high pressure on the production of dies for both internal and external use, and additional machine tool plant is to be installed. In the works, a new oil-fired furnace has been added, also a carbon-dioxide plant for sand cores.

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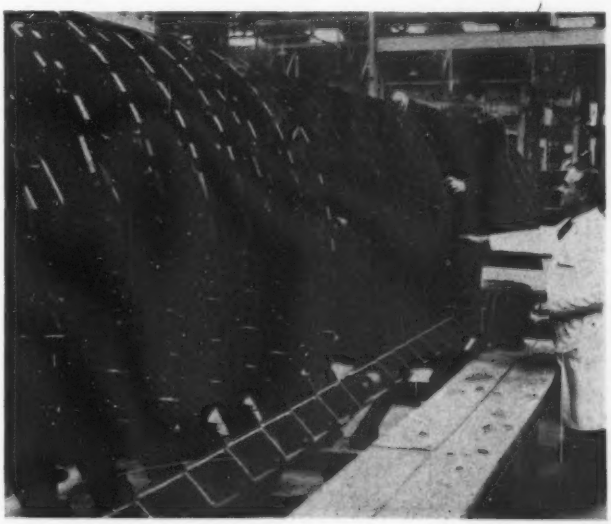
Bakelite P992 paper-based laminate material is extensively employed in the jigs and fixtures for assembly of the airframes for the new Bristol twin-rotor helicopters. For this purpose the material offers the advantages of lightness, strength, and wear resistance. The illustration shows part of the fuselage side panel assembly jig which incorporates Bakelite laminate formers



DAVID BRIDGE & CO., LTD., Castleton, are doing a good business in a variety of machinery for the rubber, plastics, and cable-making industries, both at home and abroad. Orders include calenders, mixers, mills, and presses of various capacities. As a member of a group of British firms, the company is sharing in a contract for plant required for a tyre factory to be erected in Russia. A regular demand is reported for the firm's range of friction clutches.

W. R. ANDERTON & CO., LTD., Castleton, are steadily employed on home and overseas orders for their various types and sizes of friction clutches. Orders in hand cover disc, multi-plate friction, and automatic centrifugal clutches. Other activities include the production of power take-off units, with reduction gears, for application to diesel oil engines.

JOHN HOLROYD & CO., LTD., Holfos Works, Rochdale, are well placed for orders for Holfos bronze centrifugal castings. Bushes for machine tool bearings are in good request, and there is an increasing call for fully-machined bushes. The agricultural machinery and tractor industries are also good customers for centrifugally-cast bronze bushes and gear rings. An expanding business is reported in shell-moulded castings, and tubes and bearing bushes with " spun-chilled " bores are another active line. We may note the recent installation of a broaching machine.

DAVID BROWN INDUSTRIES, LTD., JACKSON DIVISION, Salford, have recently developed an improved gear cutting technique whereby single-start hobs are used for cutting double-helical gears, of small gap width, normally produced by end milling. The single-start hob is traversed across the gear face as far as possible without contacting the opposite helix. Subsequently, the hob is removed from the machine, and an end-mill cutter is mounted in the spindle for completing the small sections of the teeth adjoining the gap.

H. B.

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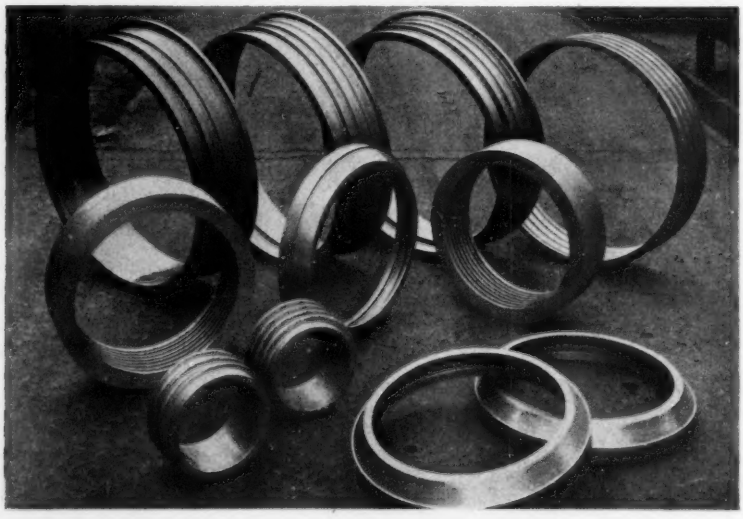
Examples of Centri-spun stainless and heat resisting stainless steel castings made by Firth-Vickers Stainless Steels, Ltd., for the Rolls-Royce Avon (200 series) jet propulsion unit. There are 16 Centri-spun components in all, ranging from a small housing to a nozzle box and outer casing. The company began development work on the Centri-spinning process in the early 1930's and has since gained extensive experience with this type of casting for the aero-engine industry



The Midlands

BOREMASTERS OF KENILWORTH, Mill End, Kenilworth, now have four Newall jig boring machines, the most recent of which is a Mk.II type 2436 machine. This firm is still very busy with work for the aircraft industry and for nuclear energy projects, and shift working is necessary. As a result the combined working time for the jig boring machines now exceeds 500 hours per week. Eventually this company will move from the existing premises to new works which will be built on a site in the Kenilworth district. A large part of the site, which extends to approximately 10 acres, will not be required by Boremasters, and the surplus land will be made available for additional industrial development.

G. P. GEAR & ENGINEERING CO., LTD., Common Lane, Kenilworth, Warwickshire, have many orders in hand for the production of gears covering a wide range. Equipment is installed here for cutting all types of gears except spiral bevels, including specially adapted machines for racks.

R. T. W. ENGINEERING, LTD., Common Lane,

Kenilworth, are engaged on sub-contract work which involves the production of a variety of components to close tolerances. In addition, this company produces form gauges and roller type tools for sizing and burnishing bearing surfaces. The rollers used in these tools are produced with a surface finish of 5 to 6 micro-inches. Other work undertaken by the firm includes the manufacture of hydraulic components. The premises provide an area of 2,000 sq. ft.

ABRASIVE DEVELOPMENTS, LTD., High Street, Henley-in-Arden, Warwickshire, report an increasing demand for their vapour blasting machines which are available in various sizes and types for different applications. With the equipment originally produced by this firm for vapour blasting, a mixture of abrasive and water was ejected from a nozzle by air pressure against the surface of the work. Later machines incorporate a specially designed centrifugal pump which ejects an abrasive mixture at a greater velocity than is obtainable with air pressure. This equipment is widely used for polishing the bores of tubular components, for example, fuel pipes for aircraft, where descaling is of great importance. The process is known as Aqua blasting. Still higher velocities can be imparted to the abrasive mixtures by the Vaqua blasting process, in which the actions of the centrifugal pump and compressed air are combined to produce surface finishes, on previously machined parts, of less than 5 micro-inches. The full range of equipment made by the company provides for surface finishing a variety of materials. Tests have shown that the fatigue life of springs may be extended by vapour blasting. Flash from plastics mouldings can be removed quickly by this process, and other applications include descaling the surfaces of titanium sheets. An airless cleaning machine in course of development is intended for cleaning ships' plates with abrasive material comprising steel shot and aluminium oxide.

F. W. H.

Nottingham

METALLIFACTURE, LTD., Dakeyne Street, Nottingham, who specialize in the supply of precision coarse pitch screws, are finding it necessary to increase their manufacturing facilities in order to keep pace with the demand for their services from a wide range of industries. Special machines, developed by the company, are used to produce internal and external threads of all forms. Work in progress includes lead screws for well-known machine tool builders, worm drives for calculating machines, tapered screws of a special design, scroll cams, heavy duty screws for vehicle self-starting equipment, and threaded textile machinery parts.

External threads up to 12 in. diameter, by 8 ft. 6 in. long, and up to 6 in. diameter with unlimited length, and internal threads up to 12 in. diameter, can be produced with the available equipment, which includes thread-cutting, generating, grinding, and rolling machines. Multi-start threads are frequently cut to meet customers' requirements. A department of this firm, occupying a separate works, is fully occupied with the manufacture of screw jacks, of which some 10,000 are supplied weekly to the motor vehicle industry.

JOHNSON PRECISION INSTRUMENTS, 240-246 Huntingdon Street, Nottingham, a company associated with Metallifacture, Ltd., are fully occupied with orders, from the hosiery and aircraft industries, for a variety of light precision assemblies of a specialized nature.

NEWEY ENGINEERING CO., LTD., Brook Street, Nottingham, are experiencing a good demand for their Brook high-speed shaping machines which are reported to be selling well in the United Kingdom and overseas. This shaper is made in three sizes, with 14-, 18-, and 24-in. strokes. The larger machines can be fitted with a swinging table which tilts through 90 deg. to the right and left, from the horizontal position. Castings are produced and machined here as part of the company's activities, which include work on a contract basis for makers of presses, abrasive wheel cutting-off machines and other machine-shop equipment. The foundry, which was established during the 19th century, is equipped to produce castings up to 25 cwt., for the machine tool, mining, agricultural, and electrical industries.

F. W. H.

Engineering Manufacture Conference

A conference on Technology of Engineering Manufacture, sponsored by the Institution of Mechanical Engineers, will be held from March 25 to 27 in the Assembly Hall, Church House, Great Smith Street, Westminster, S.W.1. Detailed arrangements are being completed by a planning panel under the chairmanship of Dr. D. F. Galloway, Wh. Sch. A provisional programme has been issued, and there will be two sessions concerned with the forming of materials, two with machining of materials, and one with inspection techniques. In addition, a session will be devoted to general discussion.

Among the many individual papers, the following may be noted: Some aspects of precision cast-

ing; flow forming, and spinning; a method of producing hollow precision forgings in non-ferrous alloys; die forging—general principles; cold heading and upsetting processes; sintered metal machine components; some aspects of the cold extrusion of metal; impact extrusion; electro-polishing; Hydrabrasion; machining of heat- and corrosion-resistant steels and alloys; machining of titanium alloys; turning with ceramic and sintered oxide tools; machining of hard metallic materials by electrical methods; machining by means of ultrasonic methods; recent developments in precision boring; recent developments in broaching; band machining and friction sawing; developments in large machine tools; automatic control of machine tools; application of optics to engineering inspection; inspection of surface finish; and inspection of large components.

Letters to the Editor

[The Editor does not hold himself responsible for the views expressed by his correspondents.]

The Introduction of Inventors to Manufacturers

[*To the Editor of* MACHINERY]

SIR,—We believe that many readers of MACHINERY would be interested in the efforts of the Institute of Patentees and Inventors to introduce the inventors of new products and new techniques to manufacturers. The need for such a service has never been greater in this country, which is faced with unprecedented competition overseas. At the same time, the rivalry between individual manufacturers becomes ever keener.

Industries which maintain their own research establishments are, perhaps, adequately supplied with new ideas, but some smaller industries and manufacturers, to our knowledge, are faced with difficulties beyond their resources to solve, and would be receptive to suggestions for new products It is extraordinary that this situation should prevail in a country famed for originality of invention, and with an enormous, untapped reservoir of inventive talent at its disposal. At the moment the talent of British inventors is either being misused or totally ignored, and it is this situation that we are seeking to remedy.

It is in the national interest that inventors should devote their time and abilities to the development of products with high commercial potentials, and to the solution of production problems which now act as a brake upon the efficiency of our industries. Some manufacturers have already brought us their problems, and we have enabled them to benefit from the work of independent inventors. At the same time, we have been able to introduce to other manufacturers the inventors of marketable ideas, again to their mutual advantage.

In this connection the Institute acts confidentially as an intermediary, providing a common meeting ground. It is most desirable that greater use should be made of such facilities, which can only be provided satisfactorily by an impartial and non-profit-making organization.

R. O. SUTHERLAND,
General Secretary.
Institute of Patentees and Inventors,
207-208 Abbey House,
2-8 Victoria Street, S.W.1.

Improving Productivity in Small- and Medium-batch Work

(*Continued from page* 291)

would follow a general flow from raw-material bay to finished-part stores.

The efficiency of assembly operations frequently depends on careful planning of the workshop layout. Where small batches of different assemblies are handled, and any line arrangement, with stations alongside a conveyor or transfer bench, is provided, the line, or parts of it, may be idle for considerable periods. One manufacturer in this country has introduced an ingenious arrangement to expedite the assembly of switch units, which are made in small batches of many different types. Assembly is carried out at long benches, with removable sections, which are designed so that they can be secured in openings in the main bench top, or can be moved away on casters. Each section may have a plain top or may carry a riveting press, drill, or other assembly aid. With this system, the bench can readily be arranged with plain and machine-carrying stations in a certain order for building one type of assembly, and when the batch of work has been completed, the layout can easily be re-arranged to suit a different sequence of operations for another type of work.

Clearly, productivity for small- and medium-batch work can never be as high as it is for mass-production operations. The few examples cited, however, should serve to indicate that, by an analytical approach to the tasks involved, and the exercise of careful thought and ingenuity, methods and equipment can be devised for substantially improving output, for an outlay that is in keeping with the modest sizes of the batches that are being processed.

Lecture on Impact Extrusion

A lecture entitled Impact Extrusion was recently delivered to the Coventry Section of The Institution of Production Engineers by Mr. H. W. Byles of Wickman, Ltd.

The speaker pointed out that impact extrusion has become well established for the production of a variety of parts in aluminium and other non-ferrous metals, and has been extensively employed in the U.S.A. and elsewhere for making components in ferrous metals, principally for armaments. Considerable development work already carried out, notably in Germany and the U.S.A., had indicated that the field for extrusion of ferrous metals might eventually be wider than for the non-ferrous group. The process offered advantages, for example, for the production of ferrous metal components such as power cylinders, gudgeon pins, cups for needle bearings, bushes, parts for fuel injection pumps, pistons, and blanks for special nuts. A selection of steel parts which had been produced in this country by impact extrusion was available for inspection at the meeting, and some of these items are shown in the illustration.

In connection with the preparation of ferrous metal blanks for impact extrusion, Mr. Byles explained that they were usually produced from bar stock, and whereas cropping avoided metal wastage, the pieces cut off were often slightly distorted and affected by local work hardening. Consequently, a sizing operation was usually carried out on blanks produced by cropping, in order to obtain the necessary close fit in the die, so as to avoid the risk of punch deflection during extrusion. Annealing of the blanks might also be necessary, depending upon the extent of upsetting involved in the sizing operation. Attention was also drawn to the importance of surface treatment of blanks, to avoid the risk of seizure with the punch—and probable failure of the tool—during extrusion. For surface treatment of ferrous metal blanks, a phosphor coating was generally applied by the Bonderizing process, followed by a lubricant.

During the lecture, two new short films were shown, one of which, entitled "Impact Extrusion," has been made by Wickman, Ltd. It deals mainly with the extrusion of containers in non-ferrous metals, and in the opening stages, the techniques for producing such parts by forward extrusion, backward extrusion, and combined forward and backward extrusion of the metal are explained by animated diagrams. In later sequences, a German-built Herlan horizontal toggle-action extrusion press, with a magazine feed, is shown set-up for producing containers on a fully automatic cycle. This press, it is explained, has a maximum operating speed of 65 strokes per min., and is representative of a range with capacities from 34 to 800 tons.

Reference is then made to the German-built range of Maypress under-driven crank presses and open- and straight-sided toggle presses, up to 1,200 tons capacity, which are suitable for the extrusion of steel components. Developed in the U.S.A., the H.P.M. hydraulic presses, shown in the concluding stages of the film, are being built under licence by Cravens, Ltd., Sheffield, and enable extrusion of steel parts to be carried out under loads exceeding 1,000 tons.

Of German origin, the second film shows a Maypress 300-ton under-driven press fitted with a dial feed, which is set up for producing steel components by impact extrusion.

M2

Some Examples of Steel Parts Which Have Been Produced By Impact Extrusion

Books Received

MACHINE TOOLS FOR METAL CUTTING. By W. H. Armstrong. McGraw-Hill Publishing Co., Ltd., 95 Farringdon Street, London, E.C.4. 347 pp. [37s. 6d. net.]

A useful introduction to the subjects of metal cutting and machine tools, this book describes the principal types of equipment, including lathes, and boring, drilling, milling, planing, broaching, and cutting-off machines. The author also discusses measurement, and limits and fits. Among other topics covered, may be mentioned grinding, electrical-discharge machining, ultrasonic machining, and chemical milling.

INDUCTION AND DIELECTRIC HEATING (Electricity and Productivity Series No. 6). Published by the British Electrical Development Association, 2 Savoy Hill, London, W.C.2. 191 pp. [Price 8s. 6d. net.]

Induction and dielectric heating, although very convenient for many manufacturing purposes, obviously do not provide the answer to every industrial heating problem. This book has been written to assist management executives—both technical and non-technical—in selecting suitable applications. It is divided into three parts, which are devoted to the induction melting of metals, induction heating for metallurgical purposes, and dielectric heating and its uses. The various applications discussed include surface hardening, through heating, heat treatment, brazing, welding and soldering, and hot pressing of powders, also heating in the plastics, woodworking, and foundry industries. The text is accompanied by numerous line drawings and photographs.

BEARING DESIGN AND APPLICATION. By D. F. Wilcock and E. R. Booser. McGraw-Hill Publishing Co., Ltd., 95 Farringdon Street, London, E.C.4. 464 pp. [Price 94s. 0d. net.]

In this book, the authors have provided a practical guide to the designer in selecting and designing bearings, and arranging for efficient lubrication.

The various types are grouped under the headings of roller bearings and sliding bearings. In connection with the former, apart from design, selection and lubrication, attention is devoted to inspection and the investigation of faults. Among the sliding bearings discussed are journal types both with and without pressure lubrication, also reciprocating load, thrust, and externally pressurized bearings. Hydrodynamic and boundary lubrication are systematically examined, and some aspects of the subject are treated mathematically. Considerable graphical and tabular data are included, and the standpoint throughout is very practical.

THE FIRST STEP IN EUROPEAN INTEGRATION. By Sir Cecil Weir, K.C.M.G., K.B.E., M.C. EUROPE—THE NEXT STEPS. By Paul Bareau. Federal Educational and Research Trust, 20 Buckingham Street, London, W.C.2. 29 pp. and 23 pp. [Price 1s. 6d. each.]

These pamphlets are the first two of a series of five, sponsored by the Trust. The theme of the series is: Where do we go from here?—Britain in the second half of the 20th century. In the first pamphlet, which is concerned with the European Coal and Steel Community, the opening chapter is devoted to "origin and objectives," and subsequent chapters to the organization and methods of operation, achievements, external relations, and chronology of the Community. The second pamphlet, sub-titled "Towards a Supermarket," includes chapters under the headings: the birth of an idea; the Treaty of Rome; the protectionist taint; Britain and the Common Market; the Free Trade Area; and the sacrifice of sovereignty.

Other pamphlets in the series will be entitled: Atlantic Union; Britain and the Commonwealth; and forty years on.

MACHINE TOOLS—WHAT THEY ARE AND HOW THEY WORK. By Herbert D. Hall and Horace E. Linsley. The Machinery Publishing Co., Ltd., National House, 21 West Street, Brighton, 1. 436 pp. [Price 52s. 6d. net.]

This book provides an introduction to the machines and processes employed in the modern machine shop, and the organization required for efficient production. The subject matter, comprising 16 chapters, is divided into two sections, the first of which is concerned with the purpose of machine tools, and the second with the various types of these machines.

In the first section there are chapters on such subjects as gauging and inspection, organizing for production, and time and motion study. Chapters in the second section are devoted to drills and drilling machines, lathes, planing and shaping, milling, grinding, press-work, and transfer machines. In addition, there are short sections on gear cutting and broaching.

The contents of this book have been selected with considerable discrimination, the sequence is well chosen, and the text is ably illustrated throughout by drawings and photographs.

BEHAVIOUR OF METALS AT ELEVATED TEMPERATURES. Published for the Institution of Metallurgists by Iliffe & Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. 122 pp. [Price 21s. 0d. net.]

Since 1947, the Institution of Metallurgists has held an annual refresher course for its members. This volume contains the lectures delivered during the 1956 course.

In the introductory lecture, Dr. N. P. Allen, F.R.S., discusses the effects of high temperatures on the engineering properties of metals. He also explains the principles to be followed in developing alloys with good mechanical properties at high temperatures. The second lecture, by Mr. G. Meikle, B.Sc., F.I.M., deals with the effects of temperatures up to 450 deg. C., with particular reference to air-frame structures and guided missiles.

Dr. L. B. Pfeil, F.R.S., considers the effects of temperatures of 500 deg. C. and above on non-ferrous metals, and describes what is being done to provide improved materials for high-temperature service. The final lecture, by Mr. W. E. Bardgett, B.Sc., A.M.I.Mech.E., F.I.M., is devoted to high-temperature steels and indicates how extended research is leading to a sounder basis for the selection of compositions for particular applications.

Trade Publications

SHELL-MEX AND B.P., LTD., Shell-Mex House, Strand, London, W.C.2.—Book with reproductions of a series of humorous advertisements in colour by Peter Kneebone, on the theme "oiling the wheels of industry."

JOHN DUGDILL & CO., LTD., Hazel Grove, Nr. Stockport. Catalogue of movable industrial electric lighting fittings, including wall bracket, bench standard, lathe slide, and drawing board bracket types.

ARMSTRONG PATENTS CO., LTD., Eastgate, Beverley, Yorkshire. Leaflets concerned with various products of the company including hydraulic remote control units, a universal stillage, and Heli-Coil thread repair kits.

BLACK AUTOMATIC CONTROLS, LTD., Leafield, Corsham, Wilts.—Data Sheet LG describing the company's range of solenoid gas valves which can be supplied in shut-off, by-pass, hand re-set, and safety switch types.

ALLAN LEVIN, LTD., 4 Drapers Gardens, Throgmorton Avenue, London, E.C.2. Leaflet giving particulars of IFO Cordierite strainer cores for foundry use. Of Swedish make, these cores are moulded under pressure and kiln dried.

U.D. ENGINEERING CO., LTD., Abbey Works, Cumberland Avenue, Park Royal, London, N.W.10. Folder describing the UDEC fully automatic universal stacker which provides for building stacks of crates, cases, and boxes up to seven units high.

SOAG MACHINE TOOLS, LTD., Juxon Street, Lambeth, London, S.E.11.—Folder giving a classified selection of machine tools from the company's extensive stocks. Another publication gives brief particulars of some representative gear cutting machines.

WOODHOUSE & MITCHELL, Wakefield Road, Brighouse. Brochure containing a description and specification of the 70 Junior 7-in. centre lathe. Various features are illustrated and there is a folding plate in four colours which shows the lathe very effectively. Another brochure is concerned with the No. 369 turret milling machine which was first shown at the Olympia Exhibition in 1956 and is now in production.

MICROMATIC HONE CORPORATION, 8100 Schoolcraft Avenue, Detroit 38, Michigan, U.S.A. This company's service and equipment catalogue, which is well arranged and fully illustrated, includes sections on the Microhoning process, cylindrical Microhoning machines, raceway and spherical Microhoning, coolant, fixtures, tools, abrasives, automatic Microhoning, flat Microhoning and services. A. A. Jones & Shipman, Ltd., Narborough Road South, Braunston, Leicester, are agents and licensees in this country for Micromatic Hone Corporation.

AERO RESEARCH, LTD., Duxford, Cambridge. Illustrated booklet of 32 pages entitled Araldite Resins for Tooling, which is devoted to the company's range of Araldite epoxy resins, and methods whereby tools for various purposes may be fabricated. After a short introduction, there are sections concerned with the making of jigs, fixtures and duplicate models; press tools; drop hammer dies; rubber press tools; stretch-blocks; vacuum forming tools; matched moulds and rubber bag moulds; joggle blocks; hammer forms; router jigs; and other applications of Araldite resins. A list of suppliers of fillers, glass fibres, and release agents for use in making plastics tools is also included.

Railway Engineering Abstracts

The Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1, and the British Transport Commission publish jointly, each month, *Railway Engineering Abstracts*, which are free to members of the Institution who have need of them, and can be purchased from the Institution by non-members. The abstracts summarize articles on all the latest developments and techniques in railway engineering, whether civil, mechanical, or electrical, from some 40 international publications. In addition, 30 other publications of abstracts are kept under constant review, and those of interest to the railway engineer are reprinted. The abstracts, which usually comprise some 200 words, outline the contents of the articles, and a code of suffixes indicates the numbers of photographs, drawings, and tables associated with them. The engineer can thus decide whether or not a particular article is worthy of his further attention.

Obituary

SIR HOLLAND GODDARD.—We regret to report that Sir Holland Goddard, president of Wadkin, Ltd., Leicester, died suddenly in London on the evening of January 30—his 75th birthday—after attending a Council meeting of the Machine Tool Trades Association, with which he had been closely connected for 35 years. Sir Holland was knighted in 1949 whilst President of the Association.

After completing his education at Tettenhall College, and subsequently at the Leicester College of Art and Technology, he joined the woodworking machinery business of Wadkin & Co., and became its sole proprietor on the death of his father in 1927.

The business was converted to a private limited company in 1936 and became a public company in 1951. Sir Holland resigned his executive offices of chairman and managing director when he became president in 1956. Until recently he was chairman of the Imperial Typewriter Co., Ltd., Leicester, and the National Steel Foundry (1914), Ltd., Leven.

Sir Holland Goddard

In addition, he served at various times the industries with which he was concerned, and had been a member of the Machine Tool Advisory Council, the Grand Council of the Federation of British Industries, the Management Board of the Engineering and Allied Employers National Federation, the Council of the Production Engineering Research Association, and of a number of other national and local bodies.

Industrial Notes

THE 1958 INTERNATIONAL CYCLE AND MOTOR CYCLE SHOW will be held at Earl's Court, London, from November 15 to 22.

DAVY AND UNITED ENGINEERING COMPANY, LIMITED, Sheffield, have received an order for rolling mill equipment to the value of about £4,000,000 from the South Durham Steel & Iron Co., Ltd., Middlesbrough.

OPTICAL-MECHANICAL (INSTRUMENTS), LTD., is the title under which the company formerly known as Optical & Mechanical Devices has been re-formed. The new address is 17 Station Road, Egham, Surrey (telephone number, Egham 3120).

G. A. HARVEY & CO. (LONDON), LTD., Greenwich Metal Works, Woolwich Road, London, S.E.7. Long service awards were recently presented to 77 office and works employees of the company, all of whom have completed more than 35 years' continuous service.

COUNTING INSTRUMENTS, LTD., 5 Elstree Way, Boreham Wood, Herts., have recently added to their range of products a small, non-reset, square case counter with six figures. This counter has all the features of the previously available 5-figure type.

PREMIER COLLOID MILLS, LTD., Walton-on-Thames, will now supply process and storage tanks individually designed to meet particular requirements. Tanks can be made in stainless steel, in jacketed forms, and with dished bases, if required.

THE 1958 MINIBITION organized by the Purchasing Officers Association, Wardrobe Court, 146a Queen Victoria Street, London, E.C.4, will be held in conjunction with the National Conference at Southport from October 2 to 4. Full particulars can be obtained from the secretary of the Association, at the above address.

ALUMINIUM IN HEAT EXCHANGE EQUIPMENT is the subject of a fully illustrated article in *The Aluminium Courier* (No. 40), published by The Aluminium Development Association, 33 Grosvenor Street, London, W.1. Numerous types of heat exchangers are shown, and examples of construction methods are described.

THE BRITISH THOMSON-HOUSTON CO., LTD., Rugby, are contributing £25,000 towards the cost of halls of residence now being erected in the grounds of the Rugby College of Technology and Arts. These halls are being provided for students taking sandwich courses in the engineering technologies.

WOOD, PRITCHETT & PARTNERS, LTD., Mechquip House, Goldhawk Road, London, W.12, the sole distributors of Original-Peddinghaus machines, inform us that they will shortly introduce improved power cutters and benders for high strength bars for concrete reinforcement. Each of these machines will be available in four sizes.

PERMALI, LTD., Bristol Road, Gloucester. The Permaglass Division of the company is now producing flat glass fibre sheet on a large multi-daylight press with automatic temperature control for the high-pressure hot-water-heated platens. Sheets are made in a standard size of 70 in. by 34 in., and more than 30 different grades can be supplied, to meet a diversity of requirements.

AUTOMOBILE INDUSTRY STANDARDS.—The Society of Motor Manufacturers & Traders, Ltd., 148 Piccadilly, London, W.1, have issued a number of additional standards for the British automobile industry under the general headings of non-ferrous metals, non-metallic materials, instruments and electrical equipment, lighting and signalling, trailers, engines and chassis, and "general."

KERRY'S (GREAT BRITAIN), LTD., now have offices in the recently completed Royal London Building, Baldwin Street, Bristol. In a showroom on the second floor, a number of the smaller machine tools produced by the Kerry Group is on view, including bench and pedestal drilling machines, bench presses, a 5½-in. centre lathe, and hacksawing machines. Mr. F. Barrett has been appointed manager of this Bristol branch.

SPEAR & JACKSON, LTD., Aetna Works, Savile Street, Sheffield, 4, have recently undertaken an extensive programme whereby all coal-fired furnaces in their rolling mill, forge, and heat-treatment departments, have been converted to use oil or gas. This programme was completed with the lighting-up, on January 28, of a new oil-fired furnace in the sheet mill, and smoke from the works has thus been eliminated.

THE BRITISH ELECTRICAL DEVELOPMENT ASSOCIATION, 2 Savoy Hill, London, W.C.2, have issued an 8-page illustrated brochure entitled "storage heating gives you cheaper heat from off-peak power." Three different storage systems are described in detail with the aid of diagrams and photographs, and their advantages are explained. Copies of the brochure can be obtained from the above address, or from electricity board showrooms.

YORKSHIRE IMPERIAL METALS, LTD., is the title of the new company which has been formed to carry on the copper and alloy tube, fittings, and plate activities of the Yorkshire Copper Works, Ltd., and of Imperial Chemical Industries, Ltd. The new company, with registered offices at Haigh Park Road, Leeds, controls assets valued at some £18,000,000 including the former I.C.I. plants at Kirkby (Liverpool), Smethwick (Staffs.), Landore (Swansea), and Dundee; also the former Yorkshire Copper plants at Leeds, Barrhead (Glasgow), and Castleford (Yorks.).

THE ASQUITH MACHINE TOOL CORPORATION, LTD., Halifax, are expanding their services to the heavy engineering industry. A new division has been formed within the selling organization—Drummond-Asquith (Sales), Ltd.—to advise on the design, manufacture and supply of all types of heavy steel forgings, castings, vessels, plate and structures. In this connection, Ruhrstahl A.G. Henrichshutte, Haatingen-Ruhr, have appointed Drummond-Asquith

(Sales), Ltd. as their sole representatives in the United Kingdom and Eire. The new division will operate from the company's offices in London, and factory-trained specialists will be available in industrial centres.

DECLINE IN NEW ORDERS FOR SHIPS.—The latest figures issued for the shipbuilding industry show that the flow of new orders to British shipyards has been considerably reduced by the uncertainties of world trade. Although shipyards finished 1957 with outstanding orders for 6,828,000 tons with an estimated value of £1,000,000,000, which is the largest since the all-time peak six years ago, the intake fell heavily in the second half of 1957. Orders booked in the last quarter of the year amounted to only 180,000 tons, compared with more than 600,000 tons in the first quarter. During 1957, cancellations, mainly of export orders, totalled 100,000 tons.

AN AUCTION SALE, INCLUDING MACHINE TOOLS, will be held on February 11 to 14 at M.O.S. Storage Depot, Royal Arsenal, Woolwich, London, S.E.18. The auctioneers will be Fuller, Horsey, Sons & Cassell (Dept. N), 10 Lloyd's Avenue, London, E.C.3, and among items to be offered may be noted horizontal boring machines; capstan, turret, and other lathes; surface, plain, and universal grinders; horizontal and vertical millers; pipe bending, hacksawing, drilling, and shaping machines; engineers' tools; and ball bearings. Another sale will be held on February 18 and 19 at M.O.S. Storage Depot, Ruddington, Notts. The auctioneers will be Walker, Walton & Hanson (Dept. N), Byard Lane, Bridlesmith Gate, Nottingham, and equipment to be offered will include lathes, grinding machines, punching machines, a vertical crank press, and engineers' hand tools.

Personal

MR. P. V. HILLIAR has recently taken up an appointment as works manager with J.W.B. Engineers, Ltd., Lower Road, Chalfont St. Peter, Bucks.

MR. KENNETH J. CARTER has been appointed Midlands sales representative for the Balance Division of Geo. Salter & Co., Ltd., West Bromwich. He succeeds Mr. K. H. Ellson, who is now home sales manager, Balance Division.

MR. W. DALZIEL, production manager of the Electronic and Equipment Group of The Plessey Co., Ltd., Ilford, Essex, and Mr. H. Fox Wright, contracts manager of the company, have been appointed executive directors.

MR. WALTER H. GLEDHILL has recently completed 50 years' service with the Butler Machine Tool Co., Ltd., Mile Thorn, Halifax. Mr. Gledhill has been sales manager for more than 20 years and was appointed a director in January, 1955.

MR. D. D. CAMPBELL has been appointed managing director (sales) of the Metallurgical Equipment Export Co., Ltd., 19 Victoria Street, London, S.W.1. This organization is a consortium of leading companies engaged in the manufacture of steelworks plant, and through its associates, Indian Steelworks Construction Co., Ltd. (ISCON), is responsible for the general engineering work in connection with the Durgapur Steelworks in India.

MR. P. H. MUIRHEAD, C.B.E., has resigned his appointment as managing director of Vickers-Armstrongs (Engineers), Ltd., and his directorship of that company. He will retain his other group directorships for the time being, but remains on sick leave. MR. W. D. OPHER, M.I.Mech.E., has been appointed managing director of Vickers-Armstrongs (Engineers), Ltd.

MR. ALBERT COCKCROFT, head foreman of John Pickles & Son (Engineers), Ltd., Hebden Bridge, Yorks., recently completed 50 years' unbroken service with the firm and was presented by Mr. George R. Pickles, managing director, with a gold wristlet watch. Nearly 30 years ago, Mr. Cockcroft's father, the late Mr. Joe Cockcroft, received a similar presentation after 50 years' service. Eight presentations for 50 years' service have been made at these works since the business was founded in 1862.

MR. S. R. MILLER, chairman of Fletcher Miller, Ltd., has been appointed a director of C. C. Wakefield & Co., Ltd., 46 Grosvenor Street, London, W.1, following the acquisition, by the latter company, of the Fletcher Miller Group. MR. A. GEORGE, director and secretary, and MR. R. T. MILLER, director of Fletcher Miller, are now directors of Wakefield-Dick Industrial Oils, Ltd. MR. J. C. CRAGG, manager, Stanlow Works, C. C. Wakefield, and MR. J. W. MACMAHON, general manager, Industrial Lubricants Division, and MR. L. J. WINDRIDGE, secretary of Wakefield-Dick, have joined the board of Fletcher Miller, Ltd.

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7/2/58

Coming Events

INSTITUTION OF ELECTRICAL ENGINEERS. *West Wales (Swansea) Sub-Centre.* February 13, at 6 p.m., at the Conference Rooms, South Wales Electricity Board Showrooms, The Kingsway, Swansea; paper on "Electrolytic Tinning," by J. Nelsey, B.Sc., and J. V. Peacock, B.Sc.

INSTITUTION OF ENGINEERING INSPECTION. *London Branch.* February 12, at 6.45 p.m., at the Royal Society of Arts, John Adam Street, Adelphi, W.C.2; paper on "Cost Aspects of Quality Control," by Dr. C. J. Anson, B.A. *Leeds Branch.* February 11, at 7.30 p.m., at the Leeds Church Institute, Albion Place, Leeds, 1; paper on "The Inspection and Control of Metallic Arc Welding," by L. H. Morgan. *South-Western Branch.* February 11, at 7.30 p.m., at the Grand Hotel, Broad Street, Bristol; paper on "International Standardization in Engineering," by Dr. E. L. Diamond. *Wolverhampton Branch.* February 17, at 7.30 p.m., at Compton Grange, Compton Road, Wolverhampton; film on "Pressure Die Castings;" sample castings and film supplied by the Wolverhampton Die Casting Co., Ltd. Mr. A. Munslow, technical sales manager, will be present to answer questions.

INSTITUTION OF PRODUCTION ENGINEERS. *Eastern Region.* February 12, at 7.30 p.m., at the Assembly House (Music Room), Theatre Street, Norwich; lecture on "Spark Machining of Dies," by E. Foster. *Doncaster Section.* February 11, at 7.15 p.m., at the Danum Hotel, Doncaster; lecture on "We Build the Jigmil," by R. C. Fenton. *Ipswich and Colchester Section.* February 14, at 7.30 p.m., at the Golden Lion Hotel, Cornhill, Ipswich; lecture on "Designing for Production," by A. P. Peat. *Birmingham Graduate Section.* February 11, at 7 p.m., at the James Watt Memorial Institute, Great Charles Street, Birmingham; lecture on "Metal Spraying," by W. E. Stantion. *Coventry Section.* February 11, at 7.15 p.m., at the Craven Arms, High Street, Coventry; lecture on "Spark Erosion," by Herr Ullmann. *Manchester Section.* February 17, at 7.15 p.m., at the Reynolds Hall, Manchester College of Science and Technology, Sackville Street, Manchester; lecture on "Metal Cutting Lubricants and Coolants," by D. A. Wight, B.Sc.(Eng.), P.E.R.A. *Manchester Graduate Section.* February 11, at 7.15 p.m., at the Reynolds Hall, Manchester College of Science and Technology, Sackville Street, Manchester; lecture on "Industrial Electronic Instrumentation," by R. B. Smith, and demonstration of equipment. *Rochester Section.* February 13, at 7.30 p.m., at the Assembly Room, Sun Hotel, Chatham; lecture on "Unconventional Tooling," by S. E. Kirk. *Cornwall Section.* February 13, at 7 p.m., at the Cornwall Technical College, Trevenson, Pool, Redruth, Cornwall; lecture on "Production Engineering Techniques"; lecturers in charge, F. G. Hawke, and F. A. Cheshire (members only). *Western Graduate Section.* February 12, at 7.30 p.m., at the Royal Hotel, College Green, Bristol, 1; lecture on "High Frequency Heating," by W. Rupp.

INCORPORATED PLANT ENGINEERS. *North-East Branch.* February 13, at 7 p.m., at Roadway House, Oxford Street, Newcastle-upon-Tyne; paper on "The Free Piston Engine Compressor," by R. A. Evans.

INSTITUTION OF MECHANICAL ENGINEERS. *Southern Branch.* February 12, at 7 p.m., at the Technical College, Brighton; paper on "The Economics of Plant Renewal and Replacement," by C. W. Griffiths. *North Western Branch.* February 20, at 6.45 p.m., at the Engineers' Club, Albert Square, Manchester; paper on "Radioisotopes in Engineering," by J. L. Putman. *South Wales Branch.* February 18, at 6 p.m., in the Lecture Theatre of the South Wales Electricity Board's Showrooms, The Kingsway, Swansea; paper on "Principles and Applications of Spark Machining," by D. W. Rudorff.

Scrap Metals

†LONDON.—‡Prices per ton for non-ferrous scrap metals free from iron are as follows:—clean copper wire, untinned and free from lead and solder, £130; clean heavy copper, untinned and free from lead and solder, £123; second grade copper wire, £118; clean light copper £114; braziery copper, £106; gunmetal, £114; brass mixed, £75; lead, net, £57; zinc, £30; cast aluminium, £89; old rolled aluminium, £122; battery lead, £30; unsweated brass radiators, £62; hollow pewter, £495; black pewter, £365.

MIDLANDS.—The difficulties of trading in ferrous scrap have not lessened during the past fortnight and stocks at merchants' yards continue to increase. Limited tonnages of heavy steel are being consigned to markets in the Midlands and north of this area, but very little can now be sent to South Wales, where another steelworks has closed for an indefinite period. The most difficult grade of scrap to clear is "bushy" turnings. Only one market is open in the Midlands and the small allocation (road deliveries only are accepted) is filled by Tuesday of each week.

Light iron and destructor scrap cannot be accepted at yards in great quantities, as deliveries of the compressed bundles are limited or suspended. Few permit labels for delivery of No. 8 light iron direct to blast furnaces are in circulation. Light steel scrap allocations have also been curtailed, and merchants are taking only limited deliveries for their presses, at reduced prices.

Maximum controlled selling prices are still being obtained by merchants from steelworks and blast furnaces, and it is only because scrap must be stocked at yards until markets are available, and/or sent further afield, that it has been found necessary to reduce offers.

Demand for high-speed steel scrap and turnings is very limited, and prices have eased considerably.

Current maximum control prices, delivered consumers' works, are now: *Heavy steel No. 1, 217s. 6d.; *heavy steel No. 2, 196s.; *heavy steel No. 4, 207s. 6d.; *heavy steel No. 5, 195s. 6d.; light iron No. 8, 149s.; short turnings No. 9 (free from alloy), 167s. 3d.; light steel No. 11, 164s. 3d.; bushy turnings, 117s.; short alloy turnings, 160s. 9d.; short steel No. 2, 233s. 3d.; machinery cast, 233s.

Prices may be increased up to 2s. 6d. per ton according to quantities tendered over a given period.

* For use by Round Oak Steelworks, Brierley Hill, increase by 1s. 6d. per ton.
† George Cohen, Sons & Co., Ltd., Commercial Road, E.14.
‡ Subject to market fluctuations.

New Companies Registered*

CRADLEY ENGINEERING CO., LTD., Maypole Fields, Cradley, Staffs. Registered January 29, 1958. Nom. cap.: £2,000 in £1 shares. Permanent director and chairman: J. Sidaway.

BERKSWELL ENGINEERING CO., LTD., Duggins Lane, Tile Hill, Coventry. Registered January 29, 1958. Nom. cap.: £10,000 in £1 shares. Directors: A. Cockersole and Mrs. R. I. Cockersole.

ALPHA LIGHT ENGINEERING CO., LTD., Wesley Street, Hadfield, nr. Manchester. Registered January 29, 1958. Nom. cap.: £4,000 in £1 shares. Directors: E. Ball (permanent managing director) and E. Tunnecliffe.

PHOENIX DIECASTINGS (BIRMINGHAM), LTD., 18 Gough Road, Edgbaston, Birmingham, 15. Registered January 16, 1958. To take over the business carried on as "Phoenix Diecasting Co." at Birmingham, etc. Nom. cap.: £7,500 in £1 shares. Permanent directors: R. R. Breakwell, F. Mooney, K. E. Breakwell and C. K. Mooney.

WELFORGE, LTD., Standard Works, Halesowen Street, Blackheath, nr. Birmingham. Registered January 29, 1958. To carry on the business of general engineers and machinists, etc. Nom. cap.: £1,000 in £1 shares. Directors: J. R. Dunn, L. R. Dunn, W. D. Dunn, J. R. Williams and J. I. Bills.

* From the lists compiled by Jordan & Sons, Ltd., Company Registration Agents, 116-118 Chancery Lane, London, W.C.2.

Machine Tool Share Market

Stock markets, after being dull and uncertain, with quiet conditions, became fairly active and cheerful during the past week, and although some irregularity was shown near the close, the underlying tone remained firm.

The gilt-edged section was well supported, and provided many good features, notably among British Government stocks, quotations of which moved ahead steadily.

Influenced by the upward movement in gilt-edged securities, the principal sections of the industrial share markets, after early dullness, developed a brighter trend.

Activity, however, remained at a very low level, with buying interest moderate and selective. Nevertheless, numerous small gains were recorded on balance.

Among machine tool issues Asquith Machine Tool advanced 2s. 9d. to 21s. 3d.; and Thos. W. Ward, 4½d. to 73s. 6d. On the other hand, Chas. Churchill lost 1½d. at 4s. 9d.; John Shaw & Sons (Wolverhampton), 1½d. at 12s. 4½d.; Jones & Shipman, 2s. 6d. at 21s. 3d.; Modern Engineering, 6d. at 10s. 6d.; Samuel Osborn, 1s. at 17s. 3d.; and F. Pratt, 10½d. at 18s. 6d.

COMPANY		Demon.	Middle Price
Abwood Machine Tools, Ltd.	Ord.	1/-	1/-
Armstrong, Stevens & Son, Ltd.	Ord.	5/-	7/9
Allen (Edgar) & Co., Ltd.	Ord.	£1	29/9
" "	5% Prf.	£1	15/-*
Arnott & Harrison, Ltd.	Ord.	4/-	14/-
Asquith Machine Tool Corp., Ltd.	Ord.	5/-	21/3
" " "	6% Cum. Prf.	£1	17/9
Birmingham Small Arms Co., Ltd.	Ord.	£1	26/-
" " "	5% Cum. "A" Prf.	£1	15/-
" " "	6% Cum. "B" Prf.	£1	17/6
" " "	4% 1st Mort. Deb.	Stk.	84½
British Oxygen Co., Ltd.	Ord.	£1	30/-
" " "	6½% Cum. Prf.	£1	21/-
Brooke Tool Manufacturing Co., Ltd	Ord.	5/-	5/6
Broom & Wade, Ltd.	Ord.	5/-	10/6
" " "	6% Cum. Prf.	£1	17/9
Brown (David) Corporation, Ltd.	5¼% Cum. Prf.	£1	14/4½
Buck & Hickman, Ltd.	6% Cum. Prf.	£1	17/6
Butler Machine Tool Co., Ltd.	Ord.	5/-	6/6 ex rights
" " "	5% Cum. Prf.	£1	13/9
C.V.A. Jigs, Moulds & Tools, Ltd.	5½% Red. Cum. Prf.	£1	13/9
Churchill (Charles) & Co., Ltd.	Ord.	2/-	4/9
" " "	6% Cum. Prf.	£1	26/3†
Churchill Machine Tool Co., Ltd.	Ord.	5/-	17/6
" " "	6% Cum. Prf.	£1	18/9
Clarkson (Engrs.), Ltd.	Ord.	5/-	10/6
Cohen (George), Son & Co., Ltd.	Ord.	5/-	10/6
" " "	4½% Cum. Prf.	£1	14/3
Coventry Gauge & Tool Co., Ltd.	Ord.	10/-	16/1½
" " "	5% Cum. Red. Prf.	£1	13/9
Coventry Machine Tool Works, Ltd.	Ord.	4/-	8/6
Craven Bros. (Manchester), Ltd.	Ord.	5/-	5/9
Elliott (B.) & Co., Ltd.	Ord.	1/-	3/-xd
" "	4½% Red. Cum. Prf.	£1	13/9
Export Tool & Case Hardening Co., Ltd.	Ord.	2/-	1/9
Firth Brown Tools, Ltd.	4% Cum. Prf.	£1	12/-
Greenwood & Batley, Ltd.	Ord.	£1	46/10½
Harper (John) & Co., Ltd.	Ord.	5/-	14/4½
" "	4½% Red. Cum. Prf.	£1	12/9
Herbert (Alfred), Ltd.	Ord.	£1	57/6
Holroyd (John) & Co., Ltd.	"A" Ord.	5/-	11/-
" " "	"B" Ord.	5/-	10/-
Jones (A. A.) & Shipman, Ltd.	Ord.	5/-	21/3
" " "	7% Cum. Prf.	5/-	5/-
Kayser, Ellison & Co., Ltd.	Ord.	£1	54/-
" " "	6% Cum. Prf.	£1	18/3
Kendall & Gent, Ltd.	Ord.	5/-	7/9
Kerry's (Gt. Britain), Ltd.	Ord.	5/-	5/9
Kitchen & Wade, Ltd.	Ord.	4/-	10/9
Martin Bros. (Machinery), Ltd.	Ord.	2/-	2/4½
Massey, B. & S., Ltd.	Ord.	5/-	7/3
Modern Engineering Machine Tools, Ltd.	Ord.	5/-	10/6
Newall Engineering Co., Ltd.	Ord.	2/-	5/-
Newman Industries, Ltd.	Ord.	2/-	2/9
" "	6% Prf. Ord.	5/-	5/6
Noble & Lund, Ltd.	Ord.	2/-	4/9
Osborn (Samuel) & Co., Ltd.	Ord.	5/-	17/3 ex rights
" " "	5½% Cum. Prf.	£1	25/6
Pratt (F.) & Co., Ltd.	Ord.	5/-	18/6
Scottish Machine Tool Corporation, Ltd.	Ord.	4/-	4/9
Shardlow (Ambrose) & Co., Ltd.	Ord.	£1	35/-
Shaw (John) & Sons, Wolverhampton, Ltd.	Ord.	5/-	12/4½
Sheffield Twist Drill & Steel Co., Ltd	Ord.	4/-	35/-
" " "	5% Cum. Prf.	£1	15/-
Stedall & Co., Ltd.	Ord.	5/-	5/3
Tap & Die Corporation, Ltd.	Ord.	5/-	8/-xd
" " "	4½% Deb. 1961-1977	Stk.	82/-
Wadkin, Ltd.	Ord.	10/-	19/6
Ward (Thos. W.), Ltd.	Ord.	£1	73/6
" "	5% Cum. 1st Prf.	£1	15/-
" "	5% Cum. 2nd Prf.	£1	24/3
Willson Lathes, Ltd.	Ord.	1/-	2/4½

The Middle Prices given in the list are in several cases nominal prices only and not actual dealing prices. Every effort is made to ensure accuracy, but no liability can be accepted for any error. * Sheffield price. † Birmingham price.

BRITISH MACHINE TOOL

Exports of New Machine Tools

Countries	Vertical Boring Machines		Other Boring Machines		Drilling Machines		Grinding, Lapping and Honing Machines		Automatic Lathes		Capstan and Turret Lathes		Other Lathes		Screwing Machines	
	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £
Commonwealth																
South Africa	350 (1)	9,100	17 (2)	642	640 (61)	17,777	148 (38)	5,167	56 (2)	1,922	1,012 (23)	45,152	1,019 (52)	29,978	5 (5)	724
India	—	—	632 (9)	18,606	2,143 (42)	57,382	1,450 (35)	52,732	243 (4)	7,979	944 (18)	40,803	908 (15)	27,015	33 (2)	2,767
Pakistan	—	—	—	—	—	—	—	—	—	—	—	—	72 (2)	2,098	—	—
Australia	—	—	211 (3)	7,103	286 (9)	7 391	335 (12)	11,772	518 (6)	22,907	832 (24)	29,463	1,126 (51)	39,225	40 (2)	3,487
New Zealand	—	—	3 (3)	454	103 (10)	2,361	70 (70)	2,727	48 (1)	1,443	—	—	297 (12)	8,962	—	—
Canada	175 (1)	4,260	134 (1)	7,814	1,117 (22)	24,406	798 (29)	25,315	283 (2)	13,581	290 (6)	11,934	2,735 (91)	74,705	22 (1)	1,800
Miscellaneous	—	—	6 (4)	537	463 (65)	11,617	261 (30)	8.124	—	—	287 (9)	10,876	970 (42)	29,578	26 (4)	844
Foreign																
Soviet Union	—	—	—	—	—	—	453 (1)	23,130	—	—	—	—	—	—	—	—
Sweden	350 (1)	8,761	1 (1)	104	471 (5)	15,164	199 (4)	8,148	124 (2)	6,096	128 (3)	6,696	24 (2)	776	—	—
Norway	—	—	13 (1)	311	64 (8)	2,090	29 (2)	890	—	—	17 (1)	398	50 (8)	1,629	—	—
Denmark	—	—	—	—	172 (6)	3,253	45 (1)	2,056	—	—	—	—	24 (6)	729	—	—
Western Germany	—	—	—	—	—	—	101 (8)	12,302	—	—	—	—	10 (2)	982	—	—
Netherlands	175 (1)	4,040	—	—	197 (12)	4,862	17 (5)	829	35 (1)	1,848	354 (11)	20,747	125 (11)	4,033	—	—
Belgium	—	—	—	—	77 (5)	1,877	33 (10)	1,162	84 (2)	4,092	132 (4)	5,106	129 (27)	3,713	—	—
France	102 (1)	5,125	113 (3)	6,144	73 (3)	3,374	833 (15)	35,810	592 (7)	31,344	390 (7)	16,564	125 (5)	6,279	—	—
Switzerland	—	—	—	—	80 (2)	2,167	73 (5)	4,125	—	—	167 (3)	8,203	324 (21)	10,466	—	—
Spain	—	—	—	—	82 (2)	3,820	768 (8)	27,653	116 (3)	6,730	135 (2)	7,034	—	—	20 (1)	2,344
Italy	—	—	—	—	—	—	102 (2)	4,915	619 (4)	29,270	—	—	—	—	1 (1)	131
U.S. America	932 (5)	22,141	—	—	977 (22)	22,541	282 (10)	15,163	513 (6)	23,717	866 (21)	42,603	2,087 (80)	55,396	—	—
Miscellaneous	180 (1)	4,183	2 (2)	264	201 (56)	5,308	622 (58)	20,813	1,618 (17)	70,342	371 (10)	9,689	1,144 (85)	34,411	13 (2)	343
Total	2,264 (11)	57,610	1,132 (29)	41,979	7,146 (330)	185,390	6,619 (343)	262,833	4,849 (57)	221,271	5,925 (142)	255,268	11,169 (512)	329,975	160 (18)	12,440
Amendments to previous accounts																
Commonwealth	—	—	−25 (40)	−1,698	+22 (+38)	+1,281	—	—	+39 (+1)	+2,053	—	—	−66 (−1)	−1.050	—	—
Foreign	+49 +(1)	+3,500	—	—	+4 (+1)	+375	+62 (+3)	+5,473	−5 (—)	—	—	—	—	—	—	—

Total exports of reconditioned machine tools:—Quantity: No., 183; weight, 10,462 cwt.; value, £54,773.
Total exports of imported machine tools:—Quantity: No., 14; weight, 837 cwt.; value, £26,310.

Imports of New Machine Tools

Country of Origin	Boring and Broaching Machines		Drilling Machines		Gear-cutting Machines		Grinding, Lapping and Honing Machines		Automatic Lathes	
	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £
Western Germany	673 (4)	49,765	111 (23)	5,177	218 (15)	14,946	1,783 (110)	86,745	2,389 (79)	138,112
Belgium	214 (1)	8,910	21 (1)	531	—	—	—	—	—	—
France	932 (2)	37,659	—	—	—	—	2 (1)	242	177 (6)	20,626
Switzerland	346 (6)	27,782	43 (8)	3,027	37 (3)	4,201	272 (40)	28,513	1,174 (36)	84,242
U.S. America	—	—	—	—	387 (2)	41,705	787 (12)	89,147	258 (7)	24,276
Miscellaneous	898 (11)	24,691	257 (9)	4,712	4 (2)	367	613 (16)	31,570	409 (10)	24,072
Total	3,063 (24)	148,807	432 (41)	13,447	646 (22)	61,219	3,457 (179)	236,217	4,407 (138)	291,328
Amendments to previous accounts										
Western Germany	—	+727	—	—	—	+152	—	—	—	—
France	—	—	—	—	—	—	—	—	—	—
Switzerland	—	—	—	—	—	—	— (+1)	+115	—	—
U.S. America	—	—	—	—	—	—	—	—	—	—
Miscellaneous	—	—	—	—	—	—	—	—	—	—

Total imports of reconditioned machine tools:—Quantity: No., 27, weight, 593 cwt.; value, £8,556.

IMPORTS AND EXPORTS (Classified)

and Parts during October, 1957

Threading Machines		Milling Machines		Gear-cutting Machines		Planing, Shaping and Slotting Machines		Presses		Sheet Metal-working Machines		Sawing Machines		Other Machines		Machine Tool Parts*		Total	
Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt.	Value £	Quantity. Cwt. and No.	Value £
—	—	98 (4)	5,775	—	—	256 (3)	6,381	—	—	530 (11)	7,667	89 (9)	1,991	1,186 (31)	24,106	353	10,368	5,759 (242)	166,750
75 (2)	3,200	646 (10)	29,227	—	—	411 (1)	7,166	352 (8)	8,962	626 (14)	10,065	75 (2)	463	78 (6)	3,121	203	12,453	8,819 (168)	281,941
—	—	37 (1)	2,416	—	—	—	—	22 (2)	658	—	—	1 (1)	26	—	—	—		132 (6)	5,198
29 (1)	783	372 (12)	15,732	—	—	203 (11)	5,769	1,050 (5)	18,039	65 (67)	860	—	—	1,091 (16)	31,073	801	39,384	6,959 (219)	232,988
—	—	88 (4)	2,943	—	—	43 (2)	972	—	—	46 (9)	1,256	27 (3)	560	135 (27)	2,847	28	1,704	888 (141)	26,229
—	—	19 (2)	471	—	—	260 (3)	5,870	553 (12)	13,912	1,306 (5)	19,707	66 (6)	1,134	96 (34)	2,545	1,261	38,258	9,115 (215)	245,712
—	—	33 (1)	1,358	—	—	36 (3)	947	263 (8)	3,089	291 (10)	5,103	73 (11)	1,479	226 (54)	6,242	229	8,953	3,164 (241)	88,747
—	—	—	—	—	—	—	—	2,310 (1)	22,301	—	—	—	—	—	—	—	—	2,763 (2)	45,431
1 (1)	54	—	—	—	—	—	—	—	—	—	—	29 (1)	440	174 (82)	4,814	65	4,709	1,566 (102)	55,762
—	—	—	—	—	—	101 (5)	1,928	—	—	—	—	—	—	2 (1)	200	16	1,019	292 (26)	8,465
—	—	180 (1)	8,400	—	—	—	—	—	—	—	—	—	—	—	—	10	1,329	431 (14)	15,767
—	—	120 (2)	4,435	—	—	—	—	—	—	—	—	—	—	58 (4)	4,567	4	546	293 (16)	22,832
—	—	20 (1)	738	—	—	—	—	126 (2)	1,878	15 (1)	952	—	—	561 (2)	16,595	40	2,708	1,665 (47)	59,230
—	—	8 (1)	340	—	—	—	—	—	—	—	—	—	—	27 (2)	745	377	12,211	867 (51)	29,246
103 (1)	5,827	128 (1)	6,801	—	—	128 (2)	4,091	274 (5)	7,594	314 (2)	12,533	—	—	2,537 (26)	97,576	48	3,887	5,760 (78)	242,949
—	—	250 (1)	6,631	—	—	14 (1)	295	—	—	—	—	16 (2)	293	111 (3)	6,279	35	2,882	1,070 (38)	41,341
—	—	540 (4)	21,602	—	—	—	—	—	—	—	—	—	—	1 (1)	51	48	1,281	1,710 (21)	70,515
—	—	—	—	—	—	—	—	1,717 (2)	30,613	—	—	—	—	—	—	90	6,634	2,529 (9)	71,563
37 (4)	5,184	194 (6)	6,607	—	—	58 (2)	1,026	115 (1)	10,900	17 (1)	540	26 (3)	455	251 (30)	14,254	228	12,146	6,583 (191)	232,673
100 (1)	10,840	284 (10)	14,298	—	—	474 (21)	9,664	2,085 (8)	46,905	670 (23)	13,704	90 (13)	2,007	124 (35)	5,570	719	18,125	8,697 (342)	266,466
345 (10)	25,888	3,017 (61)	127,774	—	—	1,984 (54)	44,109	8,867 (54)	164,851	3,880 (143)	72,387	492 (51)	8,848	6,658 (354)	220,585	4,555	178,597	69,062 (2169)	2,209,805
—	—	−23 (1)	−500	—	—	—	—	−27 (−8)	−3,115	−5 (—)	—	−13 (−3)	−267	−278 (−6)	−6,904	+684	+25941	—	—
+244 (+3)	+19100	—	—	+178 (+2)	+14500	—	—	−130 (−1)	—	+34 (+3)	+675	—	—	−1001 (−18)	−60739	−135	−3,066	—	—

Figures in parentheses denote number of machines. * Not including machine-tool cutting parts.

and Parts during October, 1957

Other Lathes		Milling Machines		Planing, Shaping and Slotting Machines		Presses and Sheet Metal-working Machines		Other Machines		Machine Tool Parts*		Total	
Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt.	Value £	Quantity. Cwt. and No.	Value £
212 (18)	17,912	5,478 (53)	225,096	192 (5)	6,695	2,825 (16)	80 984	2,208 (135)	124,142	3,420	101,114	19,509 (458)	850,688
—	—	—	—	—	—	49 (2)	961	—	—	28	2,160	312 (4)	12,562
110 (3)	4,744	216 (3)	11,737	—	—	408 (3)	15,243	1 (1)	45	27	5,000	1,873 (19)	95,296
171 (3)	8,369	385 (7)	24,833	346 (1)	15,686	783 (11)	22,447	120 (6)	12,778	252	34,343	3,929 (121)	266,221
1 (2)	389	— (2)	30	37 (2)	6,316	72 (3)	9,586	4,594 (17)	351,958	1,371	180,694	7,507 (47)	704,101
242 (2)	6,910	1,205 (26)	47,611	529 (3)	7,448	1,089 (27)	33,758	1,126 (27)	38,910	339	22,340	6,711 (139)	242,389
736 (34)	38,324	7,284 (91)	309,307	1,104 (11)	36,145	5,226 (62)	162,979	8,049 (186)	527,833	5,437	345,651	39,841 (788)	2,171,257
—	—	—	—	—	—	(−1)	—	—	—	−9	−5,875	—	—
—	—	—	—	—	—	—	—	−49 (—)	−1,845	−1	−114	—	—
—	—	—	+1,000	—	—	—	—	—	—	—	−132	—	—
—	—	—	—	—	—	—	—	—	—	−8	−319	—	—
—	—	—	—	—	—	—	—	—	—	+7	+688	—	—

Figures in parentheses denote number of machines. * Not including machine-tool cutting parts.

PRICES OF MATERIALS

All prices per ton except where otherwise stated.

Pig-Iron

Foundry and Forge	
No. 3, Class 2	
Middlesbrough zone	£21 6 0
Birmingham	£20 18 3
Phos. 0·1 to 0·75%	
Birmingham	£23 17 0
Scottish Foundry	
Grangemouth	£25 3 6
Hæmatite	
English No. 1	
N.E. and N.W. Coast	£25 6 6
Scotland	£25 13 0
Sheffield	£26 15 0
Birmingham	£27 4 0
Welsh	£25 6 6

Steel Products

Medium plates	£46 1 6
Mild steel plates, ordinary*	£42 12 0
Boiler plates*	£45 2 0
†Flat bars 5 in. wide and under / †Round bars under 3 in.	£40 8 0
Billets, rolling quality, soft U.T.	£33 1 6

Phosphor Bronze

Ingots (2B8) (A.I.D.) d/d	Nominal

Copper

Cash (mean)	£164 15 0
Cold rolled and hot rolled Sheets 4 ft. by 2 ft. by 10 SWG	£228 5 0—£228 10 0
Rods ⅞ in. to 3 in. diam.	£248 15 0
Tubes, 1½ in. bore by 10 SWG, ton lots, per lb.	2s. 5½d.
Wire rod, black, hot-rolled (½–⅞ in.) English	£185 7 6

Zinc

Refined, minimum 98 per cent. purity, current month (mean)	£63 17 6

Brass

Tubes, solid draw, per lb.	1s. 4½d.
Strip 63/37, 6 in. by 10 SWG coils, ton lots	£202 15 0—£205 5 0
Rods, ¼–3 in. diam. (59 per cent copper)	1s. 7½d.

Yellow Metal

Condenser plates, per ton	£141 0 0
Rods, per lb.	1s. 8½d.

Aluminium

Ingots min. 99·5 per cent Canadian d/d	£197 0 0

Lead

Refined, minimum 99·97 per cent purity, current month (mean)	£73 0 0

Tinplates

‡U.K. Home trade:	
Handmill f.o.t. makers' works	£3 12 2½
Cold reduced, f.o.t. makers' works	£3 7 10½
U.K. Export:	
Hot rolled basis, f.o.t. works' port	74s. 0d.—75s. 0d.
Cold reduced basis, f.o.t. works' port	76s. 0d.—76s. 6d.

Gunmetal

Ingots, 85.5.5.5. ex works	£157 0 0

*N.E. Coast, N. Joint Area, Central Scottish Zone.

†U.T. soft basic.

‡Official maximum price, after allowing for adjustments for increase in price of tin.

MAKERS' PRICES

Hexagon Steel Bars[1]

Sizes in inches from 0·7049 up to 2·21 and 2·41 a/f, ex works basis	£43 4 6
Free cutting black	£47 10 0

Reeled Steel Bars[1]

Single-reeled 1½ in. upwards, f.o.t. works (+ usual extra for sizes)	£43 17 6
Free cutting	£48 2 6

High-Speed Steel

Black random length bar. All prices basic, per lb., subject to extras.

Molybdenum "66"	5s. 10½d.
Molybdenum "46"	5s. 8½d.
14 per cent tungsten	5s. 9d.
16 per cent tungsten	6s. 1½d.
18 per cent tungsten	6s. 4d.
22 per cent tungsten	7s. 5d.
5 per cent cobalt 4·75/5·25 per cent molybdenum + 6·0/6·75 per cent tungsten + 1·75/2·05 per cent vanadium (5-6-2)	9s. 6d. / 6s. 0½d.

Precision-ground, High-speed Free-turning Brass Rod[2]

½-in. dia. ± 0·00025-in. 2-ton lots, per lb.	2s. 3½d.

Grey Iron Rod

Die Cast[3] in random lengths 18 in. to 24 in. rough machined ⅛-in. above listed size. Extra for definite lengths, for hardenable alloy iron, and for orders of less than £50. Discounts for orders over £150.

	Per cwt. net. Mark I	Mark III
¾ or ⅞ in.	255s. 6d.	318s. 10d.
1 or 1¼ in.	204s. 4d.	251s. 10d.
1½ to 1¾ in.	143s. 0d.	171s. 2d.
1⅞ to 2 in.	106s. 2d.	125s. 11d.
2¼ to 3½ in.	91s. 6d.	106s. 4d.
3¾ to 12 in.	86s. 6d.	99s. 2d.

Continuous Cast

10-ft. lengths, centreless machined 1 to 3-in. dia. + 0·010 to 0·020 in., prices as quoted for die cast bar[3]

6-ft. lengths centreless ground + 0·010 in. Extra for hardenable alloy iron[4] Per cwt. net.	¾ or ⅞ in.	245s. 4d.
	1 or 1¼ in.	196s. 4d.
	1½ to 1¾ in.	137s. 10d.
	1⅞ to 2 in.	106s. 2d.
	2¼ to 3 in.	91s. 6d.

Stellite[5]

Welding Rods (plain)

¼ in. dia. per lb.	30s. 0d.

Toolbits

¼ in. sq. × 4 in., each	22s. 3d.

Precision-ground Mild Steel[2]

1-in. dia. ± 0·00025-in. 4-ton lots, per cwt.	121s. 6d.

[1] Colvilles, Ltd., Glasgow, and 17 Grosvenor Street, London, W.1. [2] Pratt, Levick & Co., Ltd., Chester. [3] Sheepbridge Alloy Castings, Ltd., Sutton-in-Ashfield. [4] "Flocast," Harold Andrews Sheepbridge, Ltd., Halesowen. [5] Deloro Stellite, Ltd., Highlands Road, Shirley, Solihull.

BASIC PRICES FROM LONDON STOCK[6]

Free Cutting Steel

Bright cold drawn:	
(Usaspead) over 1½ to 2 in.	£59 17 6
Lead bearing (Usaled)	£63 17 6
Precision ground, 1¾ in.	£81 12 6

Bright Drawn

M.S. bars (M.M.C.) over 1½ in. to 2 in.	£55 8 6
Square edge flats (Usaflat)	£72 5 0
M.S. angles (Usaspead)	£99 10 0
Casehardening (EN) (Usacase) over 1½ in. to 2 in.	£63 14 6
M.S. bars (EN3B) (Usamild) over 1½ to 2 in.	£57 8 6
Carbon manganese semi-freecutting case hardening (EN202) (Usaspead 202) over 1½ to 2 in.	£71 14 0
35/45 ton tensile (EN6) (Usen) over 1 to 1½ in.	£65 2 6
0·4 Carbon Normalised (Usaspead "40") over 1½ in. to 2 in.	£67 4 6
Carbon manganese steel to Specification EN.16.T (Usaspead 5565), per ton	£127 10 3

Ground Flat Stock

18-, 24-, and 36-in. lengths (Usaspead). List prices less 5 per cent.

Oil Hardening Cast Steel

Non-shrink (Usaspead N.S.O.H.) ¾ in. to 2¾ in., per lb.	1s. 11d.
Non-distorting heavy duty (Usaspead H.C.H.C.) ¾-in. to 2¾-in., per lb.	4s. 2d.

Silver Steel

(0·194-in. to 1¼-in.) Genuine Stubs quality, per lb.	4s. 6d. less 27½%
M.M.C. quality, per lb.	2s. 5d. + 6½%
Boxes of 16 assorted sizes ⅛-in. to ¾-in. dia.	7s. 6d.

Stainless Steel

K.E. 40.AM (Freecutting), per lb.	3s. 3½d.

Glacier Machined Bronze Bars

Phosphor bronze (2B8) / Lead bronze	Prices on application

High-speed Steel

18 per cent. tungsten. Prices on application.

Toolholder bits:

Usaspead "Super" / "Supreme" / Cobalt 10	List price

Shimstock

Steel assorted, per tin	3s. 6d.
Brass " "	7s. 3d.

[6] Macready's Metal Co., Ltd., Pentonville Road, N.1. Subject to confirmation by London Office. Delivered free by van in London area.